# Essays on pensions and savings

Zandberg, Eelco

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Eelco Zandberg

# Contents

## *Chapter 1*

# Introduction

## 1.1 Introduction

Most Western countries face an aging population. For example, in the Netherlands the ratio of workers to pensioners will fall from four in 2012 to two in 2040[1]. In other Western countries, the numbers are comparable. This is caused by two things: First, the Post-World War II baby boom. This event will have a temporary effect on the age structure of Western countries. The second cause, increasing life expectancy, is permanent. Although increasing life expectancy is a joyful thing in itself, it poses large challenges to health care costs and the economic viability of pension systems.

Several measures have been taken to meet the aging challenge. The legal retirement age has been increased, measures have been taken to increase labor supply among older workers, and some countries are switching from a pay-as-you-go pension system to a funded system. All these measures are part of the solution to the aging problem, but might have other effects as well. For example, Davis and Hu (2008) claim that funding of pensions spurs economic growth.

A related development is the trend from defined benefit towards defined contribution schemes. An important feature of a defined contribution system is that individuals (or households) have to absorb investment shocks, interest rate shocks, and inflation shocks themselves, while in a defined benefit system intergenerational risk sharing spreads these shocks out over different generations. Therefore, the shift towards defined contribution can be seen as part of the broader shift towards more individual responsibility. Saving for retirement becomes more and more an individual task, also in the Netherlands.

[1] Source: CBS StatLine, http://statline.cbs.nl.

This thesis aims to answer important questions related to aging and saving behavior of households: How do retirement replacement rates affect saving behavior of households? What are the macroeconomic effects when governments decide to reform the pension system? These two questions are the main focus of attention of this thesis. To be a bit more specific, this thesis consists of four studies. The first three studies (Chapters 2, 3, and 4) examine life-cycle saving patterns, while the last study (Chapter 5) deals with the presumed link between funding of pensions and economic growth.

The effect of retirement replacement rates on saving behavior is important, because retirement replacement rates are declining in most Western countries. This is partly caused by the shift from defined benefit towards defined contribution schemes. But also defined benefit schemes are becoming less and less generous. To prevent a steep drop in standard of living after retirement, people thus need to save in addition to their pension scheme.

Examining life-cycle saving patterns (Chapters 2, 3, and 4) is also motivated by the observation that out-of-pocket medical expenses hardly exist in the Dutch health care system, that public pensions are very generous and that the private pension system is among the best worldwide. So why do people save so much? Considering it from a life-cycle perspective, the fact that the elderly hardly dissave already suggests that there is no need for it.

As we noted above, one of the measures that has been taken to confront aging is funding of pensions. The topic of Chapter 5 is motivated by one of the main arguments in favor of funding of pensions, namely that funded pension systems are more resistant to large shocks to the age structure of the population than unfunded pension systems. However, as Barr (2000) explains, also funded pension systems are vulnerable to demographic shocks. According to him, the idea that funding of pensions resolves adverse demographics is one of the ten myths about pension reform. However, quite some countries are reforming their systems at great costs. Therefore, we want to examine whether there are macroeconomic effects of these reforms and whether these effects are positive or negative.

The rest of the introduction is organized as follows: Section 2 describes Chapters 2, 3 and 4 of this thesis. After a short introduction of the topic we will state for each Chapter its research question, the main findings, and the conclusions. Section 3 offers a short introduction to Chapter 5, of which the theme slightly diverges from Chapters 2, 3, and 4, again with research question, main findings, and conclusions.

## 1.2 Chapters 2-4

### 1.2.1 Introduction

Since the life-cycle and permanent income hypotheses were posited almost 60 years ago (Modigliani and Brumberg, 1954, Friedman, 1957) many studies have tested their implications. One of those is that households, confronted with a hump-shaped lifetime-income profile, save when they are young and decumulate their savings after retirement, in order to smooth consumption over the lifetime.

Initially, age-wealth profiles were examined using only discretionary wealth. The results of these kinds of analyses are mixed (see Browning and Lusardi (1996)). Most studies simply do not find that households decumulate wealth after retirement and if they do, only at a very slow pace. Several explanations were developed for the lack of dissaving during retirement. The most important among these are a precautionary saving motive, uncertainty concerning the time of death and a bequest motive.

An alternative explanation is provided by Jappelli and Modigliani (2006). They argue that mandatory pension premiums are part of saving and, on the other hand, pension benefits are not part of income that is consumed but wealth decumulation (see also Auerbach et al. (1991), Gokhale et al. (1996) and Miles (1999), among others). According to them, failing to take pension wealth into account would bias the results of testing the life-cycle hypothesis towards rejecting it. They then show that adding pension wealth to discretionary wealth produces a perfectly hump-shaped age-wealth profile for Italian households.

However, this ignores the fact that the design of a mandatory pension system automatically leads to a hump-shaped age-wealth profile. The decision to accumulate wealth through the pension system and decumulate wealth after retirement is fully beyond the control of households. In that sense it is questionable whether it constitutes a valid test of the life-cycle model to include pension wealth as it is not the outcome of a deliberate saving decision by households[2]. On the other hand, it is clear that ignoring the pension system and only looking at discretionary wealth is misleading as well.

Therefore, we propose a test of the life-cycle hypothesis that uses only discretionary wealth but takes the effects of the pension system on wealth accumulation (and decumulation) into account. In Chapter 2 we do this in an indirect

[2] This is not to say that taking pension wealth into account is not important to calculate aggregate saving rates more accurately.

way using Dutch data. We test whether educational attainment is related to the amount of wealth that households accumulate before retirement, and decumulate after retirement. This approach exploits differences in the retirement replacement rate between groups of Dutch households with different educational attainment. In Chapters 3 and 4 we use U.S. data. Chapter 3 is mainly descriptive, we discuss how we calculate retirement replacement rates from the Health and Retirement Study (HRS) and examine which factors correlate with the retirement replacement rate. Finally, in Chapter 4 we directly examine the link between retirement replacement rates and saving behavior, using the replacement rates that we calculated in Chapter 3.

### 1.2.2 Chapter 2: Research Question, Findings, Conclusions

In Chapter 2, the following research question is dealt with:

***Do households with higher educational attainment have steeper age-wealth profiles than households with lower educational attainment?***

Our contribution to the literature is twofold: First, we take the retirement replacement rate as the basis of our analysis of differences in age-wealth profiles between groups of households. Second, we use a long panel (1995-2011) with Dutch data (DNB Household Survey (DHS)), which enables us to observe changes in household wealth over time. The combination of high data quality and a long panel makes the DHS very suitable for our purpose. Other datasets are the IPO (Inkomens Panel Onderzoek), and the Socio-Economic Panel (SEP), which consists of administrative data. As Alessie et al. (1997) and Kapteyn et al. (2005) note, stocks, bonds, and savings accounts are severely underreported in the SEP and the level of measurement error is not constant over time.

To test some of the implications of the life cycle-permanent income hypothesis we examine education-specific age-wealth profiles at the household level. Our sample is an unbalanced panel of 17 years (1994-2010) and approximately 2500 households of Dutch data. We find that, even after controlling for permanent income, highly educated households accumulate more non-housing wealth during working life than low-educated households. Furthermore, only highly educated households seem to decumulate non-housing wealth after retirement. On the other hand, most households hardly decumulate housing wealth after retirement.

Especially the finding that the behavior of highly educated households is broadly in line with the life-cycle hypothesis, suggests that this group of households would be able to handle more freedom of choice with respect to saving for retirement in the Netherlands. Of course, higher financial literacy might have caused the results, but this is an additional argument for more individual freedom of choice regarding pensions.

### 1.2.3 Chapter 3: Research Question, Findings, Conclusions

In Chapter 3, the following research questions are dealt with:

***How can the retirement replacement rate of households be calculated from the HRS data? Which factors correlate with the retirement replacement rate?***

The aim of this chapter is mainly descriptive. We show how to calculate replacement rates from the HRS data, describe the main features of our measure, and examine which factors are correlated with the replacement rate. Two other studies calculate replacement rates from other data sources: Bernheim et al. (2001) calculate income replacement rates from the Panel Study on Income Dynamics for 430 households and use these to test the effect of replacement rates on wealth accumulation. Hurd et al. (2012) construct replacement rates by education level and marital status for groups of households in several OECD countries to examine the effect of the generosity of public pensions on saving for retirement.

We find that the year of birth of the household head has a positive effect on the first pillar retirement replacement rate, and a negative effect on the overall retirement replacement rate. In other words, the generosity of Social Security has improved over the years but employer-provided pension plans and 401(k) have become less generous. The gradual increase in generosity of Social Security is probably due to the fact that Social Security benefits are pegged to wage inflation instead of price inflation. In addition, the higher the household head's level of education and the level of household income, the lower the replacement rate. Finally, the timing of retirement only has an effect on the first pillar retirement replacement rate. The later the moment of retirement, the higher Social Security benefits.

### 1.2.4 Chapter 4: Research Question, Findings, Conclusions

In Chapter 4, the following research question is dealt with:

***Do households with a lower retirement replacement rate have steeper age-wealth profiles than households with a higher retirement replacement rate?***

There is a large amount of studies about the displacement effect of pensions on nonpension wealth. Among them are the seminal contributions by Feldstein (1974, 1996) and Gale (1998). The main question in this literature is whether pension wealth crowds out nonpension wealth. Estimates of this displacement effect range from close to zero (no crowding out) to close to minus one (full crowding out). Related to this, we study whether the replacement rate affects households' saving behavior, and in particular whether age-wealth profiles are affected by the replacement rate of households. So, unlike the displacement literature, we do not use pension wealth but replacement rates. One of the main differences between the displacement literature and our approach is that we follow households over time, whereas most studies that estimate the displacement effect rely on cross-sectional household data.

Although some recent papers (see, for example, Engelhardt and Kumar (2011)) use administrative data to calculate pension wealth, most papers in the displacement literature use survey data. To calculate pension wealth from survey data requires many assumptions. To calculate replacement rates we only need to observe income before retirement, and income after retirement. The drawback, on the other hand, of our approach is that we are not able to accurately calculate a displacement effect between -1 and 1. Nonetheless, we are able to test the most important implications of the life cycle model.

We study the impact of the retirement replacement rate on households' saving behavior by using the RAND HRS data file. We estimate quantile regressions with the ratio of wealth to permanent income as dependent variable, and age dummies and the retirement replacement rate, instrumented by the median retirement replacement rate over census regions and industry sectors, as main independent variables. Our study is the first to explicitly link retirement replacement rates to age-wealth profiles. We have three main findings. First, based on IV regressions we are unable to conclude that the amount of financial wealth that households have accumulated around the age of 65, relative to permanent income, is decreasing in the replacement rate. Second, the age-wealth profile of households in the highest quartile of the replacement rate-distribution is very flat. Their saving rate is very low and constant over the lifecycle. Finally, households hardly decumulate wealth after retirement and some groups even keep saving after retirement.

These results imply that we can not find evidence that U.S. households accumulate more wealth in response to pensions becoming less generous. In light of several studies that claim that U.S. households are not saving enough for retirement (Mitchell and Moore, 1998, Wolff, 2002, Skinner, 2007), this finding means that making pensions less generous will worsen the financial situation of retired U.S. households.

## 1.3 Chapter 5

### 1.3.1 Introduction

Pension systems can be funded, unfunded, or partly funded. In an unfunded pension system, or pay-as-you-go (PAYG) system, the currently young pay taxes that are used to pay pensions to the currently old in the same period. In a funded pension system, young workers contribute to a pension fund and then receive pension benefits from this fund when they retire. In a PAYG system, no pension assets exist, because the contributions are immediately used to pay pension benefits; a funded system instead has a pool of assets available. During the last few decades quite some countries have transformed their pension system from a PAYG system to a (partly) funded system. A notable example is Chile, which switched to a funded system in the 1980s.

However, the switch from a PAYG system to a funded system carries a transition burden. When the PAYG system was introduced, the first generation of retirees received a pension benefit without ever having paid for it. This windfall gain has to be paid back implicitly when the transition to a funded system is made. A few studies (Holzmann, 1997a,b, Davis and Hu, 2008) suggest that during the transition from a PAYG system to a funded system economic growth might increase, which could partly alleviate the transition burden. The main causes of higher economic growth are a higher saving rate, a more efficient labor market, and capital market development.

### 1.3.2 Chapter 5: Research Question, Findings, Conclusions

In Chapter 5, the following research question is dealt with:

***Does an increase in the degree of funding of pensions lead to higher economic growth?***

Our measure for the degree of funding is the ratio between pension assets and GDP. A higher degree of funding increases this ratio. We contribute to the existing literature by taking the effects of the level of income at the start of the reform period, and the rate of return of the pension sector into account. In addition, contrary to other studies, we examine possible short- as well as long-run effects of pension funding on economic growth. For the short-run we estimate a dynamic growth model with the growth rate of the ratio of pension assets over GDP as main explanatory variable. Our sample is an unbalanced panel of 54 countries over the period 2001-2010. To find a possible long-run effect we use a simple cross-sectional growth model and estimate it by OLS.

For the short-run, we are not able to find any effect of changes in the degree of funding on economic growth. The growth rate of pension assets is insignificant in all specifications, with coefficient estimates that are very close to zero. For the long-run the evidence is mixed. With a simple cross-sectional model we do not find an effect if we include initial income in the regression model as well; without initial income as control variable the growth rate of pension assets becomes significant and positive. The inclusion of initial income, which is negative and significant in all specifications, is motivated by the convergence hypothesis: poor countries grow faster than rich countries. However, if we estimate a model with overlapping observations we find a positive effect of funding on growth, even after controlling for initial income. The effect is small though. At most, a 10 percentage points increase in the funding ratio would increase the average economic growth rate in the four years after the change with 0.18 percentage points.

*Chapter 2*

# Education level and age-wealth profiles: An empirical investigation

## 2.1 Introduction

Since the life-cycle and permanent income hypotheses were posited almost 60 years ago (Modigliani and Brumberg, 1954, Friedman, 1957) many studies have tested their implications. One of those is that households, confronted with a hump-shaped age-income profile, save when they are young and decumulate their savings after retirement, in order to smooth consumption over the lifetime.

Initially, age-wealth profiles were examined using only discretionary wealth. The results of these kinds of analyses are mixed (see Browning and Lusardi (1996) for an overview of the relevant literature). Most studies simply do not find that households decumulate wealth after retirement and if they do, only at a very slow pace. Several explanations were developed for the lack of dissaving during retirement. The most important among these are a precautionary saving motive, uncertainty concerning the time of death and a bequest motive.

An alternative explanation is provided by Jappelli and Modigliani (2006). They argue that mandatory pension premiums are part of saving and, on the other hand, pension benefits are not part of income that is consumed but wealth decumulation (see also Auerbach et al. (1991), Gokhale et al. (1996) and Miles (1999), among others). According to them, failing to take pension wealth into account would bias the results of testing the life-cycle hypothesis towards rejecting it. They then show that adding pension wealth to discretionary wealth produces a perfectly hump-shaped age-wealth profile for Italian households.

However, this ignores the fact that the design of a mandatory pension system automatically leads to a hump-shaped age-wealth profile. The decision to accumulate wealth through the pension system and decumulate wealth after retirement is fully beyond the control of households. In that sense it is questionable whether it constitutes a valid test of the life-cycle model to include pension wealth as it is not the outcome of a deliberate saving decision by households. On the other hand, it is clear that ignoring the pension system and only looking at discretionary wealth is misleading as well.

Therefore, we propose a test of the life-cycle hypothesis that uses only discretionary wealth but takes the effects of the pension system on wealth accumulation (and decumulation) into account, albeit in an indirect way. Differences in the retirement replacement rate between groups of households will be central to our analysis. Our hypothesis is that groups of households with a relatively low expected retirement replacement rate will save more for retirement and dissave more after retirement than groups of households with a relatively high expected retirement replacement rate.

We use Dutch data for our analysis. The Dutch pension system is broadly inclusive, which means that almost every Dutch citizen is covered. Several factors influence the retirement replacement rate: The level of income, the length of the working career and the earnings profile over the working career. In contrast to low-educated workers, highly educated workers usually have a high level of income, a relatively short working career and a steep earnings profile. Furthermore, Social Security in the Netherlands (AOW) is fully independent of the level of income during working life, and equal to the minimum wage level for couples and 70% of the minimum wage level for singles. This suggests that the retirement replacement rate will be higher for low-educated workers than for highly educated workers. Furthermore, low-income households will have a retirement replacement rate of around 100%. The latter makes the Dutch system very suitable for our analyis, as these households should have no incentive for lifecycle-saving because their income hardly drops after retirement.

Van Santen et al. (2012) report a higher expected retirement replacement rate the lower the level of education in a sample of Dutch households. As they explain, this could be due to two effects: First, it might simply be the result of the design of the Dutch pension system, which is redistributive in nature. Second, these findings may reflect that highly educated individuals are better informed about the state of the pension system. If highly educated households have lower retirement replacement rates than low-educated households, the former need to save relatively more than the latter, according to the life-cycle model. Besides that, you would expect to observe highly educated households decumulating more wealth after retirement, relative to their level of income. For the Netherlands, Alessie et al. (1997) indeed find a hump-shaped age-wealth profile for highly educated households and a relatively flat profile for low-educated households.

We use data from the DNB Household Survey (DHS). To examine differences in age-wealth profiles between households with different levels of education we perform wealth regressions, while controlling for the level of permanent income. We control for possible cohort effects by dividing the dependent variable, wealth, by permanent income. Our finding is that, even after controlling for the level of permanent income, the higher households are educated the more wealth they accumulate before retirement. Furthermore, only university-educated households decumulate wealth after retirement, while households with only elementary or secondary education do not. This is in line with our expectation as the latter group of households has a retirement replacement rate that is closer to 100%, in which case there would be no need to save for retirement at all.

We also estimate regression models with interactions between a linear spline in age and the level of education. The results confirm that highly educated households, with a lower retirement replacement rate, save more for retirement. Again, this result holds after controlling for permanent income. Including housing wealth in our wealth definition shows that, especially highly educated households hardly decumulate housing wealth after retirement. They thus seem to finance their consumption needs after retirement largely by means of their financial wealth and pension benefits. It is important to note that we are not looking for a causal effect of education on saving, but merely examine differences in saving behavior between different educational groups.

Our contribution to the literature is twofold: First, we take the retirement replacement rate as the basis of our analysis of differences in age-wealth profiles between groups of households. Second, we use a long panel (1995-2011) with Dutch data, which enables us to observe changes in household wealth over time. The combination of high data quality and a long panel makes the DHS very suitable for our purpose. Other datasets are the IPO (Inkomens Panel Onderzoek) Wealth Panel, which is even of better quality but has a short time dimension (from 2005 onwards), and the Socio-Economic Panel (SEP), which consists of administrative data. However, as Alessie et al. (1997) and Kapteyn et al. (2005) note, stocks, bonds, and savings accounts are severely underreported in the SEP and the level of measurement error is not constant over time.

The rest of the chapter is organized as follows: In Section 2 we present the life-cycle model and describe the Dutch pension system. Then, in Section 3 we describe the data, followed by the econometric framework in Section 4. Results and robustness checks are in Section 5 and finally, we conclude in Section 6.

## 2.2 Theoretical Considerations

In this section we provide a description of the Dutch pension system, and we shortly introduce the life-cycle permanent-income hypothesis (LC-PIH) and the implications of differential replacement rates for wealth accumulation over the lifetime.

### 2.2.1 The Dutch Pension System

The Dutch pension system consists of three pillars. The first pillar is the basic old age state pension (AOW) that everybody will receive from the age of 65 years onwards[1]. The size of this state pension is independent of the level of income, i.e. everybody receives the same amount which is equal to the net minimum wage for couples and 70% of the net minimum wage for singles. The second pillar constitutes private pension plans which are provided by the employer. Although these plans are not mandatory, de facto they are as they are part of negotiations between representatives of employers and employees in each sector. The third pillar consists of voluntary supplementary pensions that anyone can buy from insurance companies.

While the first pillar of the pension system is unfunded, the second pillar is fully funded. Workers and employers pay pension premiums to a pension fund from which they receive a pension benefit when they reacht the retirement age. Their contributions are invested in financial markets. The second pillar used to be almost fully defined benefit, but there is currently a trend towards defined contri-

[1] The legal retirement age will be increased to 67 years in the coming years.

bution. It is important to stress that the wealth data in this study does not include occupational pension wealth that is accumulated in the second pillar. The latter represents a large fraction of Dutch household wealth (Van Ooijen et al., 2015), but, as explained above, our interest lies in saving behavior conditional on a given pension arrangement.

The retirement replacement rate is defined as the ratio between net pension income from the first two pillars and net labor income just before retirement. Due to the existence of the first pillar with its flat benefit level, the Dutch pension system is redistributive in nature, which implies that the retirement replacement rate will be decreasing in the level of income. The benchmark gross replacement rate is about 70% for a median career worker, although net replacement rates are a bit higher as retirees do not pay social security taxes and pension premiums (Van Duijn et al., 2013).

### 2.2.2 Life Cycle Model

The LC-PIH states that individuals (or households) will consume a constant fraction of their lifetime income. Because, in general, labor income shows an upward sloping profile until retirement and suddenly drops afterwards, individuals will accumulate wealth while working in order to finance consumption during retirement. The theory was originally developed by Modigliani and Brumberg (1954) and Friedman (1957).

In its most simple form, it implies that wealth $W$ at time $t$ is equal to accumulated savings (see e.g. Kapteyn et al. (2005)), i.e.:

$$W_t = W_0 + \sum_{\tau=1}^{t} (y_\tau - Y_\tau^P),$$

where we assume for simplicity that the interest rate and the rate of time preference are equal to zero. Furthermore, $W_0$ is initial wealth, $y_\tau$ is non-capital income at time $\tau$ and $Y_\tau^P$ is permanent income[2] at time $\tau$. Thus, the theory says that individuals will save the difference between current income and permanent income. If labor income is more or less hump-shaped over the lifetime, saving should be positive before retirement and negative after retirement.

Because a perfectly hump-shaped age-wealth profile was hardly ever found in the first generation of empirical studies about the LC-PIH (King and Dicks-

[2] Permanent income is defined as the annuity value of present and future income (Kapteyn et al., 2005).

Mireaux, 1982), the original theory has been adapted in several ways. For example, if households have a bequest motive wealth may not decline at all after retirement because households behave as if they have an infinite horizon (Barro, 1974, Hurd, 1989). Also, if agents have a precautionary saving motive the standard life-cycle model with intertemporally additive quadratic utility functions, perfect capital markets and perfect certainty (or agents maximizing expected utility) may offer very unreliable predictions of saving behavior (Browning and Lusardi, 1996). Finally, the behavioral life-cycle model (Shefrin and Thaler, 1988) takes into account the problem of self-control, which causes individuals to depart from rational behavior.

There is a very large empirical literature that examines age-wealth profiles (or saving rates) with micro-data (see Browning and Lusardi (1996) for a survey). However, there are only a few studies that explicitly investigate differences in wealth accumulation between educational groups. Solmon (1975) already finds that education has a positive effect on saving rates. He uses a cross-section of households and explicitly looks for a causal effect from education to saving rates. However, in this study we are investigating differences in saving behavior between groups with different educational attainment, and not looking for a direct effect from education to saving.

For the Netherlands, Alessie et al. (1997) find a hump-shaped age-wealth profile for highly educated households and a relatively flat profile for low-educated households, while Hubbard et al. (1995) conclude the same for the U.S. Avery and Kennickell (1991), Bernheim and Scholz (1993) and Attanasio (1998) all find higher saving rates for highly educated households than for low-educated households in the U.S. According to Browning and Lusardi (1996), these findings are difficult to reconcile with the standard LC-PIH. However, if the institutional setting in the U.S. is comparable to the Netherlands (the expected retirement replacement rate is decreasing in educational attainment) this is doubtful. Our hypothesis is that these differences can be explained by differences in expected retirement replacement rates between educational groups.

The effect of differences in replacement rates on wealth accumulation can be examined quite easily in a life-cycle permanent-income framework. The well-known consumption Euler equation is given by:

$$U'(C_t) = E_t[U'(C_{t+1})\frac{1+r}{1+\rho}],$$

where $U(.)$ is an intratemporal utility function that is assumed to be strictly concave and maximized by the agent, $C_t$ is consumption in period $t$, $r$ is a constant real interest rate and $\rho$ is the rate of time preference. If we assume that agents have access to a risk-free asset with return $r$, that $r = \rho$, and that the utility function is quadratic, the following holds (Hall, 1978):

$$C_t = E_t[C_{t+1}]. \tag{2.1}$$

So, expected consumption in period $t + 1$ equals consumption in period $t$. In other words, consumers will smooth consumption over their lifetime.

To illustrate the effect of the retirement replacement rate consider a two-period consumption model. In the first period, the agent works and in the second period he or she is retired. Let $Y_1$ be (labor) income in period 1 and $Y_2$ be (pension) income in period 2. Furthermore, let $\theta$ be the retirement replacement rate, equal to $\frac{Y_2}{Y_1}$. There is no lifetime uncertainty and $r = \rho = 0$. According to equation (2.1), consumption will be equalized across periods. Thus, $C_1 = C_2 = \frac{(1+\theta)Y_1}{2}$. Saving $S$ in period 1 and 2 is given by, respectively $S_1 = Y_1 - C_1 = \frac{1-\theta}{2}Y_1$ and $S_2 = Y_2 - C_2 = \frac{\theta-1}{2}Y_1$.

This shows that in the most simple model the saving rate $S/Y$ only depends on the retirement replacement rate $\theta$. In addition, by assuming homothetic preferences $S/Y$ does not contain productivity-related cohort effects anymore. Furthermore, a lower retirement replacement rate (lower $\theta$) increases saving before retirement ($S_1$) and decreases saving (increases dissaving) after retirement ($S_2$). Of course, in this simple set-up saving and dissaving are exactly equal to each other. However, we abstract from other saving motives such as precautionary saving. If such a motive would be present, the total level of saving would be higher before retirement. On the other hand, if households keep saving for precautionary reasons after retirement we might not observe any dissaving at all (see De Nardi et al. (2009, 2010)).

Van Santen et al. (2012) report that the average expected retirement replacement rate is decreasing in the level of education in a sample of about 600 Dutch individuals over the period 2007-2009. Note that their data is about expected replacement rates, which do not necessarily equal realized replacement rates, as Bottazzi et al. (2006) and Van Duijn et al. (2013) show. However, individuals base their saving decisions, among other things, on expected replacement rates as they do not know yet what their realized replacement rate will be in the future. Therefore, expected replacement rates are the right measure to use. For individuals with only elementary education they find an expected replacement rate of 88%, for secondary-educated

81%, for college-educated 76% and for university-educated 75%. Correcting for the level of income, this implies that highly educated households have a higher saving rate than low-educated households in order to smooth consumption over the lifetime.

## 2.3 The Data

We base our empirical analyses on the DNB Household Survey (DHS). Since 1993, about 2500 Dutch households of the CentERpanel[3] are asked, on a yearly basis, to fill in a questionnaire with questions about their financial position, labor market position, household characteristics, and health status. The questions relate to the past year. For example, in the questionnaire of 1993 information should be provided about the level of several asset and debt categories on the $31^{st}$ of December 1992.

We use the waves from 1995 onwards, as the data of the first two waves is too incomplete and unreliable to use in a panel data analysis. Up to 1999 the households are divided into two panels, one with a representative sample of the Dutch population and the other with a random sample of households in the highest income decile (the high-income panel). The representative panel consists of about 2000 households and the high-income panel of about 500 households. From 2000 onwards the dataset only contains the representative panel. We will perform our benchmark analyses with the representative panel, but will estimate all models with the households from the high-income panel included as well as a robustness check. However, all summary statistics that we show concern only the representative sample. Note that we do not use sample weights, so our summary statistics are not corrected for possible over- or underrepresentation of certain groups.

We take the household, and not the individual, as our unit of analysis. The main rationale for this choice is that the data does not allow a clear separation of wealth between different household members.[4] Besides that, in most households financial decisions will be taken at the household level, not at the individual level. One of the drawbacks of this method is that households, unlike individuals, do not have a unique birth year. We take the birth year of the oldest household member as the birth year of the household and the highest education level within the household

[3] A group of about 2500 households that form a good representation of the Dutch population.

[4] Although in principle each household member fills in a questionnaire, it turns out to be impossible to determine wealth levels on an individual basis.

as the education level of the household. The appendix explains how the different education levels are defined. Note that for households where the level of education is time-invariant we take the mode. For couple households, we simply add wealth and income of both household members to arrive at wealth and income levels of the household.

We drop all children, grandparents and 'other members of the household' to make sure that every household consists of either one or two adult persons. Ignoring the wealth of possible children in the household is justified because children normally take their wealth with them when they leave the parental home[5]. We also drop all individuals who are self-employed as their financial position is too complicated to be used for a test of the life-cycle model. Furthermore, we drop all individuals for whom the birth year is unknown. Finally, because there exists a positive correlation between wealth levels and life expectancy (Jappelli, 1999, Attanasio and Hoynes, 2000), we confine ourselves to households with a head who is younger than 80 years old to prevent a bias towards wealthy households in the advanced age categories.

One of the well-known problems with survey data concerns measurement error. Although it is impossible to filter out all unreliable observations, we do try to identify and drop the most obvious ones. To begin with, we delete all households that report housing wealth above 10 million euros, which are only four households. Furthermore, we drop all observations where households report mortgage debt, but their house has a value of zero. This would mean that they do not own the house anymore, so a possible mortgage debt should not be counted as negative housing wealth but rather as negative financial wealth. Besides that, we suspect that most of these cases concern measurement error as well. All in all, this amounts to 102 observations.

Following Kapteyn et al. (2005) we use financial net wealth and total net wealth. The difference between the two wealth measures is that the former excludes housing wealth. The appendix provides exact details about the construction of both wealth measures. Some of the asset catgories that we include merit a bit of clarification. Browning and Lusardi (1996) discuss several issues related to the proper definitions of saving and wealth. One of these concerns the treatment of consumer durables. The life-cycle model assumes that consumers derive utility from the consumption of service flows rather than consumption expenditures, which implies

[5] Although it is difficult to determine wealth levels on an individual basis for adult members of the household, it is possible for children. Note that this is an advantage of the DHS which, unlike most other datasets, presents wealth on the individual level instead of the household level.

that the investment in durable consumption goods should be considered as saving to be consistent with the theory (Hendershott and Peek, 1989). Therefore, we include the value of consumer durables, such as cars, boats and caravans, in our definition of wealth.

Households that report missing values for all asset and debt categories are deleted from the sample. However, if they do report an amount (which may be even zero) in at least one category, all the other missing values of that particular household are assumed to be equal to zero. The reason for this assumption is that it provides us with additional observations, which would be lost if we simply delete all observations with at least one missing value in an asset or debt category. We believe it is reasonable to assume that for these households missing values constitute a value of zero, because they have provided at least one value for an asset or debt category. We deflate wealth levels by the Consumer Price Index that Statistics Netherlands (CBS) provides to ensure that all wealth levels are in real terms (1994 euros).

Table 2.1 shows summary statistics for net disposable income, financial net wealth, total net wealth, permanent income, financial net wealth divided by permanent income, and total net wealth divided by permanent income. All income measures in this study are after-tax as the DHS provides a net income variable. In the next section we will explain in detail how we calculate permanent income. Note that for financial net wealth as well as total net wealth the mean is much higher than the median, which is common in wealth data. Furthermore, the distance between the $3^{rd}$ quartile and the median is larger than the distance between the $1^{st}$ quartile and the median. This implies that the wealth distribution is rightly skewed. This is still the case after scaling by permanent income.

In total, we have 21,246 observations consisting of 5,918 different households, which means that each household is on average covered three to four times in the data set. Income data is missing for about 400 observations, but as we explain in the next section we predict these income levels so that we can use them to calculate permanent income.

Tables 2.2 and 2.3 present median financial net wealth and median total net wealth per age class for the full sample, and for each education category separately. The medians are taken over all cohorts and time periods, and are as such not a definitive indicator of a certain age-wealth profile for individual households. As expected, both financial net wealth and total net wealth are increasing in education level, although the values in the lowest age categories for households with

Table 2.1. *Summary statistics*

| | Income | FNW | TNW | $Y^P$ | FNW/$Y^P$ | TNW/$Y^P$ |
|---|---|---|---|---|---|---|
| Observations | 20,868 | 21,246 | 21,246 | 21,246 | 21,246 | 21,246 |
| Households | 5,741 | 5,918 | 5,918 | 5,918 | 5,918 | 5,918 |
| Mean | 22,326 | 31,072 | 103,561 | 17,928 | 1.847 | 6.185 |
| Standard Deviation | 29,649 | 69,501 | 152,042 | 7,620 | 4.184 | 9.112 |
| $1^{st}$ Quartile | 14,118 | 3,480 | 7,471 | 12,930 | 0.211 | 0.475 |
| Median | 19,546 | 14,058 | 53,232 | 16,664 | 0.816 | 3.065 |
| $3^{rd}$ Quartile | 26,641 | 35,275 | 151,367 | 21,498 | 2.143 | 8.905 |

Notes: *All monetary amounts are in 1994 euros. FNW = Financial Net Wealth, TNW = Total Net Wealth,* $Y^P$ = *Permanent Income. All income measures are after-tax.*

a university degree are somewhat lower than expected. This could be due to the relatively steep income profile highly educated people experience, which implies that, in the absence of liquidity constraints, they will borrow in the beginning of their adult lives (Lopes, 2008).

The main difference between financial net wealth and total net wealth, apart from the fact that the latter is consistently higher, is that total net wealth hardly declines after retirement (except for households with only elementary education) while financial net wealth does for the two highest education categories ('college' and 'university'). This could imply that, while highly educated households do seem to run down financial assets to some extent after retirement, they do not sell their house in order to satisfy their consumption needs. However, it is important to stress that age and cohort effects are not disentangled in tables 2.2 and 2.3. The age-wealth patterns that these tables seem to reveal should therefore be interpreted with caution.

Tables 2.4 and 2.5 present the same information as tables 2.2 and 2.3, but with wealth levels scaled by permanent income. The patterns are comparable to tables 2.2 and 2.3. These raw statistics already suggest that the higher households are educated the more wealth they accumulate, even after scaling for permanent income.

Table 2.2. *Median financial net wealth per age category and level of education*

| Age | Full Sample | Elementary | Secondary | College | University |
|---|---|---|---|---|---|
| 20-24 | 1,815 | 0 | 653 | 3,577 | 2,415 |
| 25-29 | 4,400 | 3,112 | 2,607 | 7,198 | 5,324 |
| 30-34 | 7,903 | 4,402 | 6,390 | 10,373 | 9,745 |
| 35-39 | 10,421 | 4,968 | 9,269 | 13,356 | 14,400 |
| 40-44 | 12,002 | 5,250 | 11,036 | 17,223 | 18,895 |
| 45-49 | 12,840 | 7,274 | 10,458 | 18,326 | 24,728 |
| 50-54 | 16,289 | 10,516 | 15,130 | 20,719 | 30,631 |
| 55-59 | 20,631 | 14,883 | 16,855 | 28,261 | 34,155 |
| 60-64 | 23,696 | 17,827 | 19,422 | 30,519 | 60,579 |
| 65-69 | 24,104 | 13,426 | 25,722 | 28,384 | 57,572 |
| 70-74 | 24,815 | 17,734 | 25,992 | 25,459 | 53,666 |
| 75-79 | 24,183 | 16,733 | 24,439 | 28,788 | 33,086 |

Note: *All monetary amounts are in 1994 euros. The educational groups are determined as follows: Survey participants who choose 'WO' are university-educated, participants who choose 'HBO' are college-educated and participants who choose either 'HAVO/VWO' or 'MBO' are secondary educated. All other participants are defined to be in the elementary-educated group. The level of education is at the household level, taking the highest level if there are two household members.*

Table 2.3. *Median total net wealth per age category and level of education*

| Age | Full Sample | Elementary | Secondary | College | University |
|---|---|---|---|---|---|
| 20-24 | 2,256 | 123 | 1,826 | 3,766 | 3,109 |
| 25-29 | 6,131 | 4,061 | 4,329 | 11,195 | 5,620 |
| 30-34 | 15,941 | 16,477 | 13,157 | 20,389 | 12,545 |
| 35-39 | 32,769 | 14,161 | 28,234 | 48,925 | 34,983 |
| 40-44 | 50,102 | 17,587 | 42,405 | 65,063 | 66,313 |
| 45-49 | 61,222 | 31,646 | 54,322 | 86,240 | 84,151 |
| 50-54 | 73,048 | 32,332 | 62,268 | 97,849 | 115,831 |
| 55-59 | 97,537 | 63,958 | 76,360 | 124,389 | 185,778 |
| 60-64 | 114,045 | 57,597 | 99,859 | 162,387 | 232,352 |
| 65-69 | 113,046 | 31,355 | 116,644 | 136,629 | 227,333 |
| 70-74 | 124,634 | 40,554 | 129,552 | 130,034 | 259,628 |
| 75-79 | 100,176 | 30,110 | 97,682 | 159,069 | 219,990 |

Note: *All monetary amounts are in 1994 euros. The educational groups are determined as follows: Survey participants who choose 'WO' are university-educated, participants who choose 'HBO' are college-educated and participants who choose either 'HAVO/VWO' or 'MBO' are secondary educated. All other participants are defined to be in the elementary-educated group. The level of education is at the household level, taking the highest level if there are two household members.*

Table 2.4. *Median financial net wealth divided by permanent income per age category and level of education*

| Age | Full Sample | Elementary | Secondary | College | University |
|---|---|---|---|---|---|
| 20-24 | 0.055 | 0.000 | 0.026 | 0.133 | 0.071 |
| 25-29 | 0.180 | 0.150 | 0.133 | 0.271 | 0.145 |
| 30-34 | 0.349 | 0.215 | 0.336 | 0.416 | 0.311 |
| 35-39 | 0.522 | 0.313 | 0.521 | 0.601 | 0.631 |
| 40-44 | 0.670 | 0.354 | 0.617 | 0.844 | 0.908 |
| 45-49 | 0.777 | 0.450 | 0.674 | 0.988 | 1.351 |
| 50-54 | 1.041 | 0.748 | 1.042 | 1.131 | 1.814 |
| 55-59 | 1.378 | 1.127 | 1.227 | 1.616 | 2.215 |
| 60-64 | 1.720 | 1.458 | 1.479 | 1.877 | 3.893 |
| 65-69 | 1.774 | 1.262 | 1.786 | 1.899 | 3.822 |
| 70-74 | 1.966 | 1.700 | 1.903 | 1.890 | 3.491 |
| 75-79 | 1.859 | 1.643 | 1.990 | 2.177 | 2.022 |

Note: *All monetary amounts are in 1994 euros. The educational groups are determined as follows: Survey participants who choose 'WO' are university-educated, participants who choose 'HBO' are college-educated and participants who choose either 'HAVO/VWO' or 'MBO' are secondary educated. All other participants are defined to be in the elementary-educated group. The level of education is at the household level, taking the highest level if there are two household members.*

Table 2.5. *Median total net wealth divided by permanent income per age category and level of education*

| Age | Full Sample | Elementary | Secondary | College | University |
|---|---|---|---|---|---|
| 20-24 | 0.090 | 0.004 | 0.048 | 0.142 | 0.090 |
| 25-29 | 0.260 | 0.232 | 0.220 | 0.406 | 0.155 |
| 30-34 | 0.701 | 0.793 | 0.703 | 0.806 | 0.473 |
| 35-39 | 1.524 | 0.770 | 1.502 | 2.194 | 1.208 |
| 40-44 | 2.791 | 1.174 | 2.792 | 3.177 | 3.420 |
| 45-49 | 3.628 | 2.056 | 3.373 | 4.352 | 5.155 |
| 50-54 | 4.428 | 2.183 | 4.002 | 5.443 | 7.174 |
| 55-59 | 6.567 | 4.704 | 5.705 | 7.300 | 10.770 |
| 60-64 | 7.918 | 5.100 | 6.986 | 9.658 | 13.181 |
| 65-69 | 8.051 | 2.654 | 8.414 | 9.568 | 13.911 |
| 70-74 | 9.389 | 3.579 | 10.289 | 9.226 | 15.231 |
| 75-79 | 8.365 | 2.911 | 7.746 | 11.295 | 12.832 |

Note: *All monetary amounts are in 1994 euros. The educational groups are determined as follows: Survey participants who choose 'WO' are university-educated, participants who choose 'HBO' are college-educated and participants who choose either 'HAVO/VWO' or 'MBO' are secondary educated. All other participants are defined to be in the elementary-educated group. The level of education is at the household level, taking the highest level if there are two household members.*

## 2.4 Econometric Framework

In the first part of this section we explain our empirical strategy and in the second part we show how we calculate permanent income.

### 2.4.1 Empirical Strategy

Panel data on wealth usually contains age, time and cohort effects. Age effects are what we are ultimately interested in in this study. Time effects especially capture the business cycle and the corresponding movement on financial markets, which affect wealth levels. Cohort effects arise if different cohorts have different levels of permanent income due to differences in productivity levels across generations (Shorrocks, 1975). They can also be caused by different attitudes towards saving between different generations. People who grew up during the Great Depression might be thriftier than generations who grew up in times of an economic boom, such as the post-war period. It is important to account for all these three effects when estimating age-wealth profiles. Failing to take cohort effects into account might give the impression of a hump-shaped age-wealth profile if older cohorts have lower average wealth holdings than younger cohorts.

It is impossible to estimate age, time and cohort effects directly in a panel because calendar year is equal to age plus year of birth (cohort). In such a model the parameters are not identified. One could assume that there are either no cohort or no time effects present in the data, but these assumptions may not be justified given past evidence. An alternative is to use the approach of Deaton and Paxson (1994). Their solution to the identification problem is to assume that the coefficients on the year dummies sum to zero and are orthogonal to a time trend. This implies that the time effects are only a reflection of business cycle effects that average out over the full sample period. However, we believe that the assumption that the year dummies sum to zero is not plausible in the case of wealth data, as (financial) wealth is a stock variable which depends on past income shocks.

Jappelli (1999) uses the fact that consumption is proportional to lifetime resources as long as preferences are homothetic. This implies that subtracting (the log of) consumption from both sides of a wealth regression drops the cohort effect from the right-hand side of the equation. He then regresses the log of the wealth-consumption ratio on an age polynomial, a set of unrestricted time dummies, and some household characteristics. Unfortunately, the DHS does not contain data on consumption, so the approach of Jappelli (1999) is not feasible for us.

We therefore choose a different strategy, namely dividing wealth by permanent income. In that case, all productivity-related cohort effects are incorporated in the dependent variable as long as quadratic utility is assumed.[6] Possible differences in preferences between different cohorts are not captured in this way. However, for example Kapteyn et al. (2005) show that permanent income and changes in Social Security can explain all cohort differences in wealth in their sample of Dutch households. We therefore believe that our approach captures most of the cohort effects. To estimate age and time effects we use a linear spline function in age and a normal set of time dummies. The spline function in age has four knots with the fourth one exactly defined at the legal retirement age of 65.

We also include a set of selectivity dummies and a set of learning dummies[7]. The selectivity dummies are meant to capture the idea that households that drop out of the sample might be different from households that participate at least one more year. The learning dummies pick up the effect that households might get better or worse in filling in the questions of the survey as they participate (Kapteyn et al. (2005)).

Attanasio and Browning (1995), among others, argue that changes in consumption needs due to changing household characteristics are important for the explanation of wealth profiles. Therefore, we include a dummy for couple households and the number of children in the house as control variables. Finally, we add a dummy for living in an urban area, and regional dummies for each province of the Netherlands. The basic model that we estimate is then as follows:

$$\frac{W_{ht}}{Y_h^P} = \sum_{i=1}^{5} \zeta_i s_i(age_{ht}) + \gamma_t + X_{ht}' \beta + \epsilon_{ht}, \tag{2.2}$$

where $W_{ht}$ is wealth of household $h$ in year $t$, $Y_h^P$ is permanent income of household $h$, $s_i$ is a linear spline function in age, $age_{ht}$ is the age of the head of household $h$ in year $t$, $\gamma_t$ is a time fixed effect for year $t$, $X_{ht}$ is a matrix of control variables discussed above and $\epsilon$ is the error term with conditional median zero. Finally, the $\zeta_i$, and the elements of the parameter vector $\beta$ are coefficients to be estimated.

[6] In the next section we explain how permanent income is constructed.

[7] The selectivity dummy is one in year $t$ if the household participates in year $t$ and at least one more time after year $t$, and zero otherwise. The first learning dummy is one if the household participates in that year for the first time, the second learning dummy is one if the household participates in that year for the second time, etc.

Note that $\text{Med}(\epsilon_{ht}|age_{ht}, X_{ht}) = 0$ as we assume that $\frac{W_{ht}}{Y_h^P}$ does not contain any cohort effects anymore. We estimate equation (2.2) for all four education categories. However, we also want to examine the differences in age-wealth profiles between low- and highly educated households in one regression framework. Therefore, we define a dummy variable *edu* that equals one for highly educated households (college- and university-educated) and zero for low-educated households (elementary- and secondary-educated). Then, we construct the interaction variables $age_i * edu$ for i = 1,2,...,5.

Adding the interaction effects and the education dummy to equation (2.2) gives the following regression model:

$$\begin{aligned} \frac{W_{ht}}{Y_h^P} &= \sum_{i=1}^{5} \zeta_i s_i(age_{ht}) + \sum_{i=1}^{5} \phi_i s_i(age_{ht} * edu_h) + \theta\, edu_h + \gamma_t \\ &\quad + X'_{ht}\, \beta + \epsilon_{ht}, \end{aligned} \tag{2.3}$$

Note that we assume the level of education to be time-invariant by taking the mode for each household[8]. Because the wealth distribution is rightly skewed and we expect influential outliers to be present, we estimate equations (2.2) and (2.3) by median regression instead of OLS. To account for heteroskedasticity and within-household dependence over time we compute cluster-bootstrapped standard errors.

### 2.4.2 Permanent Income

By definition, permanent income is not observed for individuals who are still alive. We therefore have to estimate it from the available information. Our strategy to estimate permanent income consists of three steps: First, we regress current income on a linear spline function in age, a set of Deaton-Paxson time dummies (see Deaton and Paxson (1994)), some household characteristics, and a household fixed effect. Then, based on the regression results we forecast future income levels, and backcast past income levels. In case we have data on past or future household income we replace the predicted value by the observed value. Finally, we calculate permanent income from current income and the predicted levels of past and future income.

[8] Respondents could make mistakes in filling in the questionnaire, or alternatively, the level of education might change over time if the respondent pursues an education during the survey period.

While we choose not to use Deaton-Paxson time dummies for the wealth regressions, we do think they are suitable to model income. As explained above, Deaton and Paxson (1994) assume that the coefficients on the year dummies sum to zero and are orthogonal to a time trend, which implies that they are only a reflection of business cycle effects. While it is hard to argue that this is the case for wealth, it seems a reasonable assumption for income. Furthermore, it allows us to estimate a cohort effect as well. We will describe below how we model the cohort effect.

Our model for permanent income largely follows Kapteyn et al. (2005). The main differences are: First, we backcast and forecast non-capital income, while Kapteyn et al. (2005) only forecast income. Second, Kapteyn et al. (2005) do not use Deaton-Paxson time dummies in their income regressions, while we do. If real GDP per capita around the time the household entered the labor market is used as a control variable, Deaton-Paxson time dummies are not necessary anymore to identify the coefficients of the model. However, we prefer to model the time effects in this way as the coefficients on the dummies sum to zero, which allows us to ignore time effects in backcasting income. This would not be allowed when we had estimated regular time effects.

As the income data comes from questionnaires it is subject to measurement error. In general we have no reason to assume that this measurement error is non-random. However, there seems to be one exception. Some older households, especially in the lowest education category, report income levels that are too low to be correct. In the Netherlands, every individual above the age of 65 receives a Social Security Benefit (AOW in Dutch). We observe some households with incomes that are (much) lower than the amount of AOW they should receive[9]. Therefore, we set an income floor for households with a head who is at least 65 that equals the level of the AOW benefit.

To estimate current income we largely follow the model of Kapteyn et al. (2005):

$$\log(y_{ht}) = \sum_{i=1}^{5} \beta_i s_i(age_{ht}) + \gamma_t^* + X_{ht}^{'}\rho + u_h + \epsilon_{ht}, \tag{2.4}$$

where $y_{ht}$ is net income of household $h$ in year $t$, $s_i$ is a linear spline function in age, $age_{ht}$ is the age of the head of household $h$ in year $t$, $\gamma_t^*$ is a Deaton-Paxson time fixed effect, and $X$ consists of a set of learning dummies, a set of selectivity dummies, the

[9] The only exception yields people who lived abroad between the age of 15 and 65. Their income could be lower than the standard level of the AOW benefit. However, we believe that, especially among the low-educated, this does not play an important role here.

number of children in the house and a dummy variable for couple households. The reason for including this dummy is that the level of income depends on whether a household consists of one or two adults, especially when receiving Social Security benefits after retirement. We model the individual effect $u_h$ (the Mundlak term) as follows (see Mundlak (1978)):

$$u_h = \overline{W'}_h \, \theta + \delta \log(rgdpc_h) + v_h, \tag{2.5}$$

where $\overline{W}_h$ consists of the time averages of all time-varying explanatory variables in equation (2.4) for household $h$, $rgdpc_h$ is a cohort-specific variable, which is the average level of real GDP per capita around the time household $h$ entered the labor market. This should capture possible cohort effects. We calculate average real GDP per capita for the years when the household head was between 16 and 25 years old. Finally, $v_h$ is an individual effect that we assume to be random and uncorrelated with the explanatory variables in (2.4). Modeling the individual effects in this way, we let them depend on household specific means of all time-varying right-hand side variables and a cohort effect. We insert equation (2.5) into equation (2.4) and then estimate the latter by the random effects estimator. To allow for intra-household correlation we calculate clustered standard errors. As especially education level and marital status are powerful indicators of lifetime earnings (Hurd et al., 2012) we estimate separate models for each different education category.

The learning dummies turn out to be jointly insignificant. This means that learning does not seem to play a role when respondents fill in the questionnaire. The selectivity dummies are also jointly insignificant, which suggests that there is no evidence of endogenous attrition in our sample (see Verbeek and Nijman (1992)). We therefore drop the learning dummies and selectivity dummies. Table 2.6 presents the estimation results.

The age spline variables and the Deaton-Paxson time dummies are jointly significant for all educational groups. Furthermore, the log of *rgdpc* around the time the household entered the labor market is positively significant for all education groups. This suggests that, controlling for age and time effects, households who entered the labor market in periods with low productivity, for example during a recession, experience a lower level of income during the rest of their lives, compared to households who started their working career in a high productivity period.

We also test whether the Mundlak terms that make up the individual effects are jointly significant, which they are for all groups. If they would have been insignificant we could just as well have estimated a standard random effects model, but their significance justifies modeling the individual effects as we do. As expected, the partner dummy is positively significant, the level of income of couple households is on average around 28% higher than the income of singles, while the number of children in the house does not seem to be an important predictor of income. To get a clearer idea of the age-income profiles that these results imply, we turn to a graphical presentation.

Figure 2.1 shows education-specific age-income profiles. The dashed lines represent the 95% confidence bounds. As expected, a higher level of education is associated with a higher level of income. Especially university-educated workers experience a relatively steep income profile during the first few years of their working career. This is one of the causes of the difference in replacement rates between them and low-educated households. After retirement, income drops gradually for university-educated households, and stays more or less constant for the other three educational groups. This is in line with our expectation that replacement rates are lower for highly-educated households in the Netherlands.

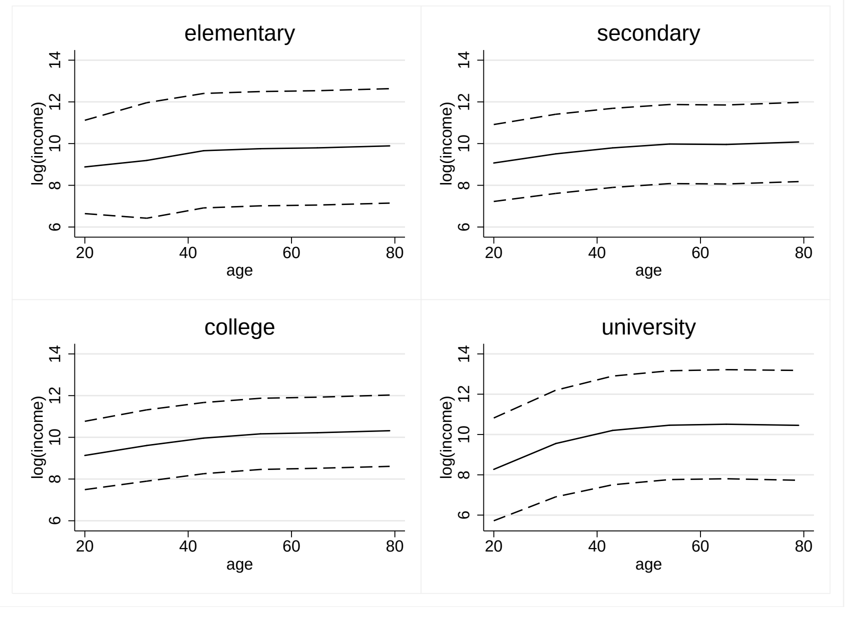


Figure 2.1. Age-income profiles (solid lines) for four different education categories. The dashed lines represent 95% confidence bounds.

Subsequently, we use the coefficient estimates as presented in table 2.6, to predict past and future incomes. Of course, the evolution of income is mainly driven by age. However, following Kapteyn et al. (2005), we also want to take into account that household characteristics might change if people age. We therefore update the number of children in the house and the presence of a partner as well. In order to be able to do this we estimate the following fixed effects regression model and use the coefficient estimates to predict how the number of children in the house and the probability of a partner change when the household ages:

$$z_{ht} = \mu_h + \sum_{a=21}^{79} \phi_a age_h + u_{ht},$$

where $z_{ht}$ is the number of children in the house or the presence of a partner of household $h$ in year $t$, $\mu_h$ is a household fixed effect, $age_h$ is an age dummy and $u_{ht}$ is a random error term with mean zero. We assume that education level is time-invariant, when we backcast and forecast income. Furthermore, we set all time dummies to zero, as we have modeled them as pure business cycle effects. Finally, we set the learning dummies and selectivity dummies equal to zero.

We have income data (either directly from the questionnaire or imputed) for approximately 98% of the sample. However, we do predict past, current, and future income of households for which income data is missing, by assuming that the individual effect equals zero for them. Then, permanent income in year $t$ equals:

$$Y_h^P = \frac{W_{h0} + \sum_{\tau=0}^{T}(1+r)^{-\tau}\hat{y}_{h\tau}}{\sum_{\tau=0}^{T}(1+r)^{-\tau}},$$

where $\hat{y}_{h\tau}$ is the predicted value of $y_{h\tau}$. Note that $\hat{y}_{h\tau}$ includes $\hat{v}_h$. The equation above states that permanent income is a weighted average of the present values of all past, current, and future incomes, where the discount factors form the weights. In case all incomes would be exactly equal to each other, these would also be equal to permanent income. One of the simplifications that we make is that we set wealth at the age of 20, $W_{h0}$, equal to zero. We assume that the interest rate $r$ is fixed and equal to 3%. Furthermore, we only calculate future income until the age of 80 and assume that it is zero afterwards (or equivalently, that people die at the age of 80). This means that $T$ equals 59 in the equation above. To keep things as simple as possible, we ignore survival probabilities because the effect will be negligible.

Table 2.6. *Income Regression Estimates*

| *Dependent variable* | log(Income) | | | |
|---|---|---|---|---|
| Education level | **elem** | **sec** | **coll** | **uni** |
| age 20-32 | 0.026 | 0.037 | 0.040 | 0.107 |
| | (0.033) | (0.010)*** | (0.010)*** | (0.015)*** |
| age 32-43 | 0.043 | 0.026 | 0.032 | 0.059 |
| | (0.014)*** | (0.005)*** | (0.006)*** | (0.011)*** |
| age 43-54 | 0.009 | 0.017 | 0.019 | 0.024 |
| | (0.006) | (0.004)*** | (0.004)*** | (0.006)*** |
| age 54-65 | 0.003 | -0.002 | 0.005 | 0.004 |
| | (0.006) | (0.005) | (0.005) | (0.011) |
| age 65-79 | 0.007 | 0.009 | 0.007 | -0.004 |
| | (0.005) | (0.004)** | (0.005) | (0.012) |
| log(rgdpc) | 0.638 | 0.535 | 0.478 | 0.569 |
| | (0.087)*** | (0.088)*** | (0.070)*** | (0.118) *** |
| partner dummy | 0.232 | 0.281 | 0.272 | 0.245 |
| | (0.080)*** | (0.056)*** | (0.052)*** | (0.134)* |
| number of children | 0.006 | 0.003 | 0.032 | -0.022 |
| | (0.026) | (0.018) | (0.019)* | (0.031) |
| $p$-value $\chi^2$-test joint sign. age spline variables | 0.004 | 0.000 | 0.000 | 0.000 |
| $p$-value $\chi^2$-test joint sign. Deaton-Paxson time dummies | 0.000 | 0.000 | 0.000 | 0.002 |
| $p$-value $\chi^2$-test joint sign. Mundlak effects | 0.004 | 0.001 | 0.032 | 0.014 |
| Number of observations | 4,736 | 7,117 | 6,212 | 2,803 |
| Number of households | 1,278 | 1,949 | 1,699 | 815 |
| $R^2$ | 0.20 | 0.20 | 0.21 | 0.25 |

Notes: *Estimated by random effects. Numbers in parentheses are clustered standard errors. *,**,*** denote significance at the 10%, 5% and 1% respectively. log (rgdpc) is het natural logarithm of the average level of real GDP per capita around the time the household entered the labor market. Deaton-Paxson time dummies are included in the specification but the individual estimates are not reported. The educational groups are determined as follows: Survey participants who choose 'WO' are university-educated (uni), participants who choose 'HBO' are college-educated (coll) and participants who choose either 'HAVO/VWO' or 'MBO' are secondary educated (sec). All other participants are defined to be in the elementary-educated group (elem). The level of education is at the household level, taking the highest level if there are two household members.*

## 2.5 Results

In this section we present the regression results. First, we show the results from estimating equation (2.2) for different education categories. Second, we present and discuss the results from estimating equation (2.3). Finally, we show results from estimating all specifications with the households from the high-income panel included.

Table 2.7 presents the results of estimating equation (2.2) for all four different education categories. The dependent variables are financial net wealth divided by permanent income (columns 1-4), and total net wealth divided by permanent income (columns 5-8). All regressions include a full set of time dummies, but we drop the selectivity dummies and learning dummies as they both are jointly insignificant.

The age spline variables are jointly significant in all eight regressions. The time dummies and regional dummies are jointly significant in some of them. Furthermore, the partner dummy is positively significant for most educational groups but is negative for university-educated households. The number of children in the house has a negative effect on wealth accumulation, but only when housing wealth is excluded. Finally, households in urban areas seem to save relatively more than households in rural areas.

The coefficients on the age spline variables for financial wealth show a pattern that is more or less consistent with our expectations. Households accumulate wealth during the working span of their lives but only university-educated households decumulate wealth after retirement. Note that our finding that the coefficient on *age* 65-79 is positive for elementary-, secondary-, and college-educated households does not necessarily imply that they do not decumulate retirement-related wealth after the age of 65. If they have a strong precautionary saving motive, this effect might undo the negative wealth effect of decumulation for retirement purposes. In that case we would still observe a positive coefficient estimate. However, it is clear that university-educated households decumulate wealth much faster after retirement.

It is essential to realize that we find these patterns while correcting wealth for the level of permanent income. Our findings are thus not merely a reflection of the fact that highly educated households have higher levels of income than low-educated households, but indicate that even if income would be equal across groups highly educated households accumulate more wealth before retirement and decumulate wealth after retirement. This is exactly what the LC-PIH predicts, considering the fact that the retirement replacement rate differs between groups with different educational attainment.

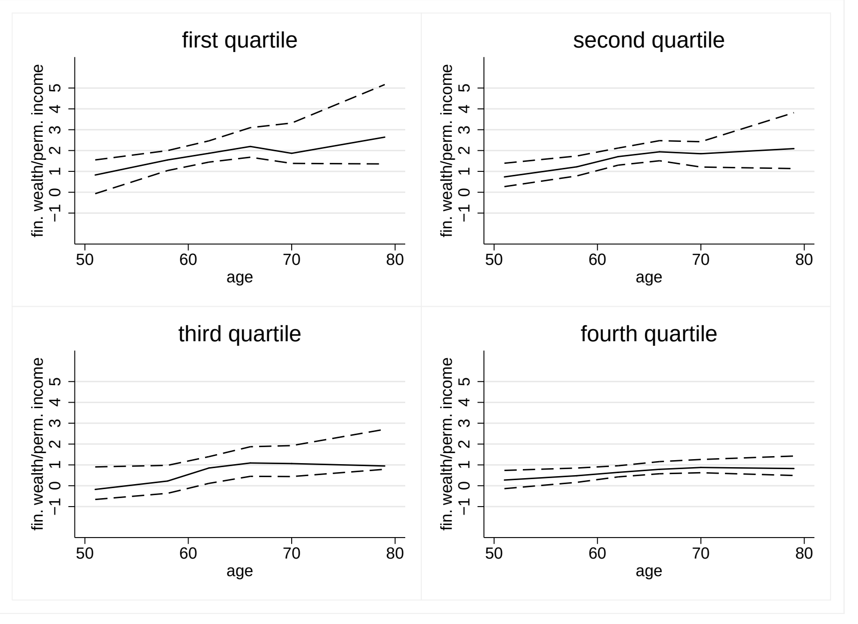


Figure 2.2. Age-financial wealth profiles (solid lines) for four different education categories. The dashed lines represent 95% confidence bounds.

Figure 2.2 shows the age-financial wealth profiles that the regression results imply. All other variables are evaluated at their means. The dashed lines represent the 95% confidence bounds. It is clear that the profile of university-educated households differs quite significantly from the others. These highly educated households save a lot more before retirement, and dissave after retirement. In contrast, the other educational groups do not save that much before retirement, and do not dissave after retirement.

Figure 2.3 presents the age-wealth profiles for total net wealth. They are comparable to the profiles for financial net wealth in the pre-retirement phase. However, after retirement university-educated households keep accumulating wealth. This suggests that university-educated households in general do not sell their house in order to finance consumption after retirement, because we find a smaller coefficient for *age* 65-79 when excluding housing wealth (see table 2.7). This finding is consistent with the conclusions of, for example, Venti and Wise (1990). In addition, Alessie et al. (1995) show that Dutch elderly finance consumption mainly through

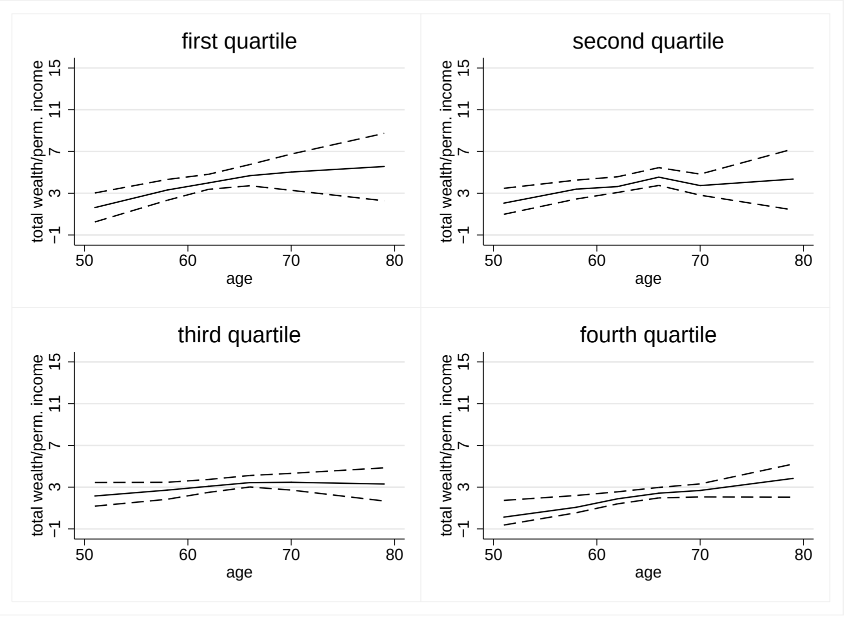


Figure 2.3. Age-total wealth profiles (solid lines) for four different education categories. The dashed lines represent 95% confidence bounds.

Social Security (AOW) and occupational pensions, and not by selling their house (or taking up a second mortgage on their house). A possible explanation might be that highly-educated households, because they are healthier on average, are able to stay longer in their own house, compared to low-educated households who might be forced by their health condition to sell their house (if they own one) and spend the last few years of their lives in a nursing home.

Jappelli and Modigliani (2006) discuss a possible bias in measures of wealth levels at advanced ages. As people respond to the survey in the next period, only the survivors are physically able to do so. However, there is a negative correlation between mortality and wealth (see, among others, Hurd et al. (2001)), which means that the survivors are on average richer than the deceased. This would mean that the sample is biased towards rich individuals, especially for the advanced age categories. We partly solved this problem by dropping all households with a head who is older than 80 years, but it remains for the group between (say) 60 and 80 years old. On the other hand, this bias only makes it harder to find a hump-shaped age-wealth profile. The fact that we do find such a profile for university-educated households makes our case stronger. For low-educated households we do not find a hump-shaped age-wealth profile, but because the life expectancy of low-educated households is much lower than that of highly educated households, it seems to be a much less serious problem for low-educated households.

Table 2.8 presents regression results from estimating equation (2.3). We show results for financial net wealth and total net wealth. The age spline variables and time dummies are jointly significant in all specifications. Furthermore, the interaction effects and the regional dummies are also jointly significant in all regressions. Overall, the results imply the same age-wealth patterns as the results in table 2.7; highly educated households (university- and college-educated) accumulate more wealth before retirement (relative to permanent income) than low-educated households, and only highly educated households decumulate wealth after retirement. The only exception is housing wealth, which is not decumulated after retirement.

Tables 2.9 and 2.10 show the results when the households from the high-income panel are included. The high-income panel consists of 551 households and 1,262 observations. The largest fraction of these households is either university- or college-educated (76%). They are surveyed up until 1999. All in all, the results do not differ much from the results with only the households from the representative panel. The main difference is that university-educated households seem to accumulate less wealth and decumulate a bit slower than in the representative panel only. However, the overall patterns are the same as in tables 2.7 and 2.8.

Table 2.7. *Quantile Regression Estimates (representative sample)*

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| *Dependent variable* | FNW | FNW | FNW | FNW | TNW | TNW | TNW | TNW |
| Education level | **elem** | **sec** | **hi-vo** | **uni** | **elem** | **sec** | **hi-vo** | **uni** |
| age 20-32 | 0.017 | 0.019 | 0.028 | 0.041 | 0.027 | 0.044 | 0.086 | -0.012 |
| | (0.015) | (0.005)*** | (0.012)** | (0.016)** | (0.075) | (0.034) | (0.040)** | (0.039) |
| age 32-43 | 0.014 | 0.013 | 0.052 | 0.078 | 0.074 | 0.141 | 0.211 | 0.247 |
| | (0.009) | (0.004)*** | (0.008)*** | (0.018)*** | (0.048) | (0.031)*** | (0.034)*** | (0.051)*** |
| age 43-54 | 0.031 | 0.012 | 0.029 | 0.075 | 0.101 | 0.095 | 0.238 | 0.518 |
| | (0.011)*** | (0.008) | (0.014)** | (0.033)** | (0.061)* | (0.058) | (0.054)*** | (0.114) |
| age 54-65 | 0.050 | 0.032 | 0.050 | 0.189 | 0.100 | 0.320 | 0.345 | 0.470 |
| | (0.017)*** | (0.013)** | (0.019)*** | (0.063)*** | (0.081) | (0.113)*** | (0.071)*** | (0.154)*** |
| age 65-79 | 0.010 | 0.009 | 0.010 | -0.155 | -0.062 | 0.107 | 0.033 | 0.063 |
| | (0.028) | (0.017) | (0.028) | (0.083)** | (0.088) | (0.201) | (0.122) | (0.206) |
| partner dummy | 0.252 | 0.151 | 0.236 | -0.231 | 1.704 | 1.524 | 0.481 | 0.267 |
| | (0.100)** | (0.046)*** | (0.077)*** | (0.134)* | (0.458)*** | (0.320)*** | (0.307) | (0.281) |
| number of children | -0.114 | -0.190 | -0.086 | -0.144 | -0.415 | -0.153 | 0.058 | 0.085 |
| | (0.035)** | (0.055)*** | (0.033)*** | (0.056)** | (0.169)** | (0.122) | (0.130) | (0.195) |
| urban dummy | 0.054 | 0.084 | 0.103 | 0.078 | 0.547 | 0.648 | 0.729 | 0.289 |
| | (0.030)* | (0.021)*** | (0.030)*** | (0.049) | (0.207)*** | (0.124)*** | (0.122)*** | (0.190) |
| $p$-value $\chi^2$-test joint significance age spline variables | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| $p$-value $\chi^2$-test joint significance time dummies | 0.047 | 0.000 | 0.002 | 0.027 | 0.204 | 0.000 | 0.000 | 0.088 |
| $p$-value $\chi^2$-test joint significance regional dummies | 0.201 | 0.001 | 0.113 | 0.180 | 0.786 | 0.004 | 0.010 | 0.672 |
| Number of observations | 4,805 | 7,247 | 6,315 | 2,843 | 4,805 | 7,247 | 6,315 | 2,843 |
| Number of households | 1,324 | 2,014 | 1,741 | 832 | 1,324 | 2,014 | 1,741 | 832 |

Notes: *Dependent variables: Financial Net Wealth/Permanent Income (FNW) and Total Net Wealth/Permanent Income (TNW). Numbers in parentheses are cluster-bootstrapped standard errors, based on 500 replications. *,**,*** denote significance at the 10%, 5% and 1% respectively. The educational groups are determined as follows: Survey participants who choose 'WO' are university-educated (uni), participants who choose 'HBO' are college-educated (coll) and participants who choose either 'HAVO/VWO' or 'MBO' are secondary educated (sec). All other participants are defined to be in the elementary-educated group (elem). The level of education is at the household level, taking the highest level if there are two household members.*

Table 2.8. *Quantile Regression Estimates Interaction Terms (representative sample)*

| | (1) | (2) |
|---|---|---|
| Dependent variable | **NFW** | **TNW** |
| age 20-32 | 0.031 | 0.050 |
| | (0.006)*** | (0.026)* |
| age 32-43 | 0.020 | 0.112 |
| | (0.005)*** | (0.025)*** |
| age 43-54 | 0.028 | 0.108 |
| | (0.009)*** | (0.049)** |
| age 54-65 | 0.050 | 0.217 |
| | (0.013)*** | (0.084)** |
| age 65-79 | 0.023 | -0.060 |
| | (0.020) | (0.110) |
| age 20-32*edu | -0.004 | -0.046 |
| | (0.010) | (0.037) |
| age 32-43*edu | 0.037 | 0.138 |
| | (0.008)*** | (0.034)*** |
| age 43-54*edu | 0.010 | 0.149 |
| | (0.017) | (0.063)** |
| age 54-65*edu | 0.016 | 0.162 |
| | (0.023) | (0.111) |
| age 65-79*edu | -0.037 | 0.106 |
| | (0.034) | (0.147) |
| highly educated | 0.109 | 1.048 |
| | (0.279) | (1.077) |
| partner dummy | 0.199 | 1.194 |
| | (0.041)*** | (0.183) |
| number of children | -0.100 | -0.119 |
| | (0.015)*** | (0.077) |
| urban dummy | 0.083 | 0.656 |
| | (0.014)*** | (0.077)*** |
| $p$-value $\chi^2$-test joint sign. age spline variables | 0.000 | 0.000 |
| $p$-value $\chi^2$-test joint sign. interaction effects | 0.000 | 0.000 |
| $p$-value $\chi^2$-test joint sign. time dummies | 0.000 | 0.000 |
| $p$-value $\chi^2$-test joint sign. regional dummies | 0.000 | 0.000 |
| Number of observations | 21,210 | 21,210 |
| Number of households | 5,911 | 5,911 |

Notes: *Dependent variables: Financial Net Wealth/Permanent Income (FNW) and Total Net Wealth/Permanent Income (TNW). Numbers in parentheses are cluster-bootstrapped standard errors, based on 500 replications. *,**,*** denote significance at the 10%, 5% and 1% respectively. The variable 'highly educated' is a dummy variable for households with university- or college-education.*

Table 2.9. *Quantile Regression Estimates (full sample)*

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| *Dependent variable* | FNW | FNW | FNW | FNW | TNW | TNW | TNW | TNW |
| Education level | **elem** | **sec** | **hi-vo** | **uni** | **elem** | **sec** | **hi-vo** | **uni** |
| age 20-32 | 0.016 | 0.037 | 0.025 | 0.040 | -0.017 | 0.050 | 0.083 | -0.002 |
| | (0.017) | (0.006)*** | (0.012)** | (0.015)*** | (0.042) | (0.036) | (0.009)*** | (0.038) |
| age 32-43 | 0.016 | 0.024 | 0.054 | 0.084 | 0.080 | 0.140 | 0.234 | 0.250 |
| | (0.009)* | (0.007)*** | (0.008)*** | (0.016)*** | (0.045)* | (0.032)*** | (0.031)*** | (0.045)*** |
| age 43-54 | 0.030 | 0.030 | 0.033 | 0.062 | 0.099 | 0.103 | 0.214 | 0.475 |
| | (0.011)*** | (0.012)** | (0.012)*** | (0.026)** | (0.060)* | (0.054)* | (0.051)*** | (0.090)*** |
| age 54-65 | 0.049 | 0.058 | 0.040 | 0.182 | 0.094 | 0.326 | 0.312 | 0.470 |
| | (0.016)*** | (0.020)*** | (0.018)** | (0.054)*** | (0.081) | (0.105)*** | (0.067)*** | (0.130)*** |
| age 65-79 | 0.010 | 0.021 | 0.008 | -0.122 | -0.060 | 0.093 | 0.049 | 0.028 |
| | (0.027) | (0.029) | (0.025) | (0.081)* | (0.086) | (0.193) | (0.120) | (0.195) |
| partner dummy | 0.260 | 0.268 | 0.259 | -0.256 | 1.729 | 1.556 | 0.559 | 0.266 |
| | (0.101)** | (0.067)*** | (0.075)*** | (0.133)* | (0.468)*** | (0.331)*** | (0.310)* | (0.286) |
| number of children | -0.119 | -0.113 | -0.089 | -0.143 | -0.419 | -0.165 | 0.035 | 0.088 |
| | (0.035)*** | (0.021)*** | (0.031)*** | (0.051)*** | (0.168)** | (0.126) | (0.116) | (0.158) |
| urban dummy | 0.054 | 0.086 | 0.097 | 0.101 | 0.523 | 0.653 | 0.691 | 0.252 |
| | (0.029)* | (0.021)*** | (0.028)** | (0.042)** | (0.213)** | (0.117)*** | (0.120)*** | (0.144)* |
| $p$-value $\chi^2$-test joint significance age spline variables | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| $p$-value $\chi^2$-test joint significance time dummies | 0.033 | 0.000 | 0.137 | 0.093 | 0.238 | 0.000 | 0.000 | 0.221 |
| $p$-value $\chi^2$-test joint significance regional dummies | 0.254 | 0.000 | 0.051 | 0.308 | 0.558 | 0.001 | 0.008 | 0.354 |
| Number of observations | 4,869 | 7,488 | 6,828 | 3,287 | 4,869 | 7,488 | 6,828 | 3,287 |
| Number of households | 1,348 | 2,121 | 1,961 | 1,032 | 1,348 | 2,121 | 1,961 | 1,032 |

Notes: *Dependent variables: Financial Net Wealth/Permanent Income (FNW) and Total Net Wealth/Permanent Income (TNW). Numbers in parentheses are cluster-bootstrapped standard errors, based on 500 replications. *,**,*** denote significance at the 10%, 5% and 1% respectively. The sample includes households from the high-income panel. The educational groups are determined as follows: Survey participants who choose 'WO' are university-educated (uni), participants who choose 'HBO' are college-educated (coll) and participants who choose either 'HAVO/VWO' or 'MBO' are secondary educated (sec). All other participants are defined to be in the elementary-educated group (elem). The level of education is at the household level, taking the highest level if there are two household members.*

Table 2.10. *Quantile Regression Estimates Interaction Terms (full sample)*

| | (1) | (2) |
|---|---|---|
| Dependent variable | **FNW** | **FNW** |
| age 20-32 | 0.033 | 0.053 |
| | (0.005)*** | (0.026)** |
| age 32-43 | 0.020 | 0.113 |
| | (0.005)*** | (0.026)*** |
| age 43-54 | 0.030 | 0.115 |
| | (0.009)*** | (0.047)** |
| age 54-65 | 0.049 | 0.221 |
| | (0.013)*** | (0.085)*** |
| age 65-79 | 0.023 | -0.072 |
| | (0.020) | (0.118) |
| age 20-32*edu | -0.004 | -0.054 |
| | (0.009) | (0.040) |
| age 32-43*edu | 0.041 | 0.152 |
| | (0.007)*** | (0.036)*** |
| age 43-54*edu | 0.011 | 0.132 |
| | (0.014) | (0.061)** |
| age 54-65*edu | 0.008 | 0.117 |
| | (0.022) | (0.107) |
| age 65-79*edu | -0.037 | 0.127 |
| | (0.032) | (0.157) |
| highly educated | 0.138 | 1.278 |
| | (0.258) | (1.168) |
| partner dummy | 0.213 | 1.228 |
| | (0.039)*** | (0.187)*** |
| number of children | -0.102 | -0.121 |
| | (0.014)*** | (0.070)* |
| urban dummy | 0.082 | 0.624 |
| | (0.013)*** | (0.070)*** |
| $p$-value $\chi^2$-test joint sign. age spline variables | 0.000 | 0.000 |
| $p$-value $\chi^2$-test joint sign. interaction effects | 0.000 | 0.000 |
| $p$-value $\chi^2$-test joint sign. time dummies | 0.000 | 0.000 |
| $p$-value $\chi^2$-test joint sign. regional dummies | 0.000 | 0.000 |
| Number of observations | 22,472 | 22,472 |
| Number of households | 6,462 | 6,462 |

Notes: *Dependent variables: Financial Net Wealth/Permanent Income (FNW) and Total Net Wealth/Permanent Income (TNW). Numbers in parentheses are cluster-bootstrapped standard errors, based on 500 replications. *,**,*** denote significance at the 10%, 5% and 1% respectively. The sample includes households from the high-income panel. The variable 'highly educated' is a dummy variable for households with university- or college-education.*

## 2.6 Conclusions

Our most important conclusion is that the amount of financial wealth accumulation before retirement and financial wealth decumulation after retirement is much higher for university-educated households than for other educational groups. There are several possible explanations for our findings. One of them is related to the retirement replacement rate. Given the fact that expected retirement replacement rates in the Netherlands are consistently lower for highly educated households, our findings are grossly in line with the LC-PIH. A lower expected retirement replacement rate implies that one has to save more for retirement in order to be able to smooth consumption. It is important to keep in mind that we find these results after correcting wealth levels for permanent income. Our findings are not driven by the fact that income is increasing in educational attainment.

Interesting to note is that Alessie et al. (2013) find a larger displacement effect of pension wealth on discretionary wealth for highly educated households than for low-educated households across Europe. An explanation could be that highly educated households save mainly for retirement, while for low-educated households the precautionary saving motive is more important. In other words, low-educated households are buffer-stock savers and highly educated households are life cycle savers (see Carroll (1997)). Our results would perfectly explain this saving pattern, especially if the retirement replacement rate for highly educated households is consistently lower than for low-educated households in most European countries.

A related explanation could be financial literacy. More financial literate households might have more realistic expectations about their retirement replacement rate and better understand the need to save for retirement. This effect should be visible through expected retirement replacement rates as well. An other issue is that the well-documented drop in consumption around retirement (Banks et al. (1998), Bernheim et al. (2001), Haider and Stephens (2007)) might explain why a large group of households (especially among the low-educated) does not dissave after retirement.

One of the limitations of our study is that we are not able to examine which factors explain the age-wealth patterns that we find. The data that we use do not give information about financial literacy, for example. Furthermore, although there is already some data on expected retirement replacement rates available for the Netherlands, it is not yet enough to use in a large panel study as we would like to do. Future research should be directed towards achieving this.

## 2.A Appendix

In this appendix we describe in detail all the variables from the DHS that we use. The questionnaire divides assets and debt into several components. Table 2.A.1 lists all non-housing wealth asset and debt categories that we use:

Table 2.A.1. *Non-Housing Wealth Asset and Debt Categories of the DHS*

| Assets | | Debt | |
|---|---|---|---|
| **b1b** | Checking accounts. | **s1b** | Private loans. |
| **b2b** | Employer-sponsored savings. | **s2b** | Extended lines of credit. |
| **b3b** | Savings, postbank account. | **s3b** | Debts hire-purchase contracts. |
| **b4b** | Deposit books. | **s4b** | Debts with mail-order firms. |
| **b5b** | Savings/deposit accounts. | **s5b** | Loans from family/friends. |
| **b6b** | Savings certificates. | **s6b** | Study loans. |
| **b7b** | Single-premium ann. insurance policies. | **s7b** | Credit card debts. |
| **b8b** | Savings/endowments insurance policies. | **s8b** | Loans not mentioned before. |
| **b9b** | Combined life-insurance products. | **x1b** | Checking acc. with negative balance. |
| **b10b** | Pension scheme, not paid for by employer. | | |
| **b11b** | Growth funds. | | |
| **b12b** | Mutual funds/accounts. | | |
| **b13b** | Bonds/mortgage bonds. | | |
| **b14b** | Shares/companies. | | |
| **b15b** | Put-options bought. | | |
| **b16b** | Put-options written. | | |
| **b17b** | Call-options bought. | | |
| **b18b** | Call-options written. | | |
| **b20b** | Cars. | | |
| **b21b** | Motorbikes. | | |
| **b22b** | Boats. | | |
| **b23b** | Caravans. | | |
| **b24b** | Money lent out family/friends. | | |
| **b25b** | Savings/investments not mentioned. | | |

The sum of the 25 asset categories minus the sum of the 9 debt categories gives financial net wealth. Table 2.A.2 lists all housing wealth asset and debt categories that we use:

Adding these three asset and debt categories to financial net wealth gives total net wealth.

Besides questions about the wealth position of participants, the DHS contains a large amount of questions about background characteristics such as year of birth,

Table 2.A.2. *Housing Wealth Asset and Debt Categories of the DHS*

| Assets | | Debt | |
|---|---|---|---|
| **b19ogb** | Real estate. | **b19hyb** | Mortgages on real estate. |
| **b26ogb** | Owner of a house. | **b26hyb** | Mortgages on the house. |
| **b27ogb** | Owner of a second house. | **b27hyb** | Mortgages second house. |

level of education, marital status, number of children etcetera. We use the following in our empirical analysis:

- **gebjaar** The year of birth of the participant. We define the year of birth of the household as the year of birth of the oldest household member.
- **oplmet** (up until the wave of 2001 called '**scholing**') The question asks participants for the highest level of education they completed. It is a multiple choice question with 9 possible answers (up until the wave of 2001 there were 12 answer possibilities). Participants who choose 'WO' are university-educated, participants who choose 'HBO' are college-educated and participants who choose either 'HAVO/VWO' or 'MBO' are secondary educated. All other participants are defined to be in the elementary-educated group. For the education dummy, we choose to call only participants with a college- or university-degree highly educated. All the other participants are low-educated. If the level of education is non-constant over time we take the mode in order to make this variable time-invariant. Finally, the level of education of the household is the highest level of education of all household members.
- **idink** Net total income, which is composed by adding several income components (such as salary, early retirement benefits, pension benefits, unemployment benefits, study loans etc.).
- **aantalki** Number of children in the house.
- **partner** Dummy variable indicating the presence of a partner.

*Chapter 3*

# The retirement replacement rate: How to calculate and which variables are correlated with it?

## 3.1 Introduction

The retirement replacement rate[1] is the ratio between income after retirement and income before retirement. As Biggs and Springstead (2008) note, there is not yet a standard method to determine replacement rates for households. There are, however, studies that use several different replacement rate measures, although not always at the level of the household.

Bernheim et al. (2001) calculate income replacement rates from the Panel Study on Income Dynamics for 430 households and use these to test the effect of replacement rates on wealth accumulation. Hurd et al. (2012) construct replacement rates by education level and marital status for groups of households in several OECD countries to examine the effect of the generosity of public pensions on saving for retirement.

The aim of this chapter is mainly descriptive. We show how to calculate replacement rates from the Health and Retirement Study (HRS) data, describe the

[1] For the sake of brevity we will refer to the replacement rate instead of the retirement replacement rate throughout the rest of this chapter.

main features of our measure, and examine which factors are correlated with the replacement rate. In Chapter 4 of this thesis we will use this measure to examine the relationship between replacement rates and age-wealth profiles of households.

Calculating a replacement rate poses several challenges: although income after retirement is straightforward to measure and fairly constant over time, income before retirement is not. An income pattern consistent with the life cycle model implies that income steadily rises with age and usually reaches a peak around the age of 50. Therefore, the question is which measure of income to use. Income just before retirement, average income in the last few years before retirement or an average over the whole working career?

Munnell and Soto (2005) discuss three issues with respect to the construction of replacement rates. The first is the timing of retirement, and especially the increasing popularity of partial retirement. The second problem is the unit of analysis. For several reasons, replacement rates on an individual basis diverge from household replacement rates. Also, the treatment of home equity raises some issues.

We calculate household replacement rates by dividing average pension income by average labor income. As we observe households only around retirement, we use average labor income from the years just before retirement instead of average income over the whole working career. Note that this should be kept in mind when comparing our replacement rates with measures that use average earnings over a longer period. As we only observe before-tax income, the household replacement rates that we calculate are before-tax as well.

To examine which factors correlate with the replacement rate of households, we estimate a simple OLS model with the replacement rate as dependent variable. We distinguish between the first pillar replacement rate ($RR_{FP}$) and the overall replacement rate ($RR_O$). $RR_{FP}$ only takes Social Security into account whereas $RR_O$ contains employer-provided pension plans and 401(k) as well. In addition, we investigate the relationship between educational attainment and the replacement rate, and permanent income and the replacement rate separately.

We find that the year of birth of the household head has a positive effect on $RR_{FP}$, and a negative effect on $RR_O$. In other words, the generosity of Social Security has improved over the years but employer-provided pension plans and 401(k) have become less generous. The gradual increase in generosity of Social Security is probably due to the fact that Social Security benefits are pegged to wage inflation instead of price inflation.

In addition, the higher the household head's level of education and the level of household income, the lower the replacement rate. Finally, the timing of retirement only has an effect on $RR_{FP}$. The later the moment of retirement, the higher Social Security benefits, which is not surprising given the design of the system.

The rest of this chapter is organized as follows. Section 2 describes the U.S. pension system. Section 3 explains in detail how we calculate replacement rates from the HRS data. Section 4 shows which variables are correlated with the replacement rate, and finally, Section 5 concludes.

## 3.2 The U.S. Pension System

In this section we will give a description of the pension system in the United States. Especially for non-American readers this might be useful to better understand the analysis that follows. This section is partly based on Diamond and Gruber (1999), McGarry (2002), Beshears et al. (2009), and information from the Employment Benefit Research Institute[2].

The first pillar of the U.S. pension system is the Social Security Retirement Program. Around 90 percent of Americans 65 years and older receive Social Security benefits.[3] The second pillar consists of employer-provided pension plans and 401(k). Employer-provided plans can be either defined benefit or defined contribution, although there is a clear trend towards defined contribution plans. 401(k) plans are defined contribution plans. The third pillar comprises personal savings, usually in the form of Individual Retirement Accounts (IRAs).

### 3.2.1 First pillar: Social Security

The official full retirement age in the United States used to be 65, but is gradually increased to the age of 67. Workers born before 1937 could still claim unreduced retirement benefits at 65, but for wokers born in 1960 or later the full retirement age will be 67. The full retirement age for cohorts born between 1937 and 1960 lies somewhere between 65 and 67, depending on their year of birth. Note that the earliest that individuals can start receiving Social Security retirement benefits is at the age of 62, but the monthly benefit is then reduced by about 30 percent (if the full retirement age is 67). It is also possible to delay retirement benefits. In that case the monthly benefit is increased by 5-8% relative to the unreduced retirement benefit,

[2] http://www.ebri.org/pdf/publications/facts/0405fact.pdf.
[3] See http://www.ssa.gov/pressoffice/basicfact.htm for some basic facts about Social Security.

although the benefit increase no longer applies if you keep delaying after the age of 70.

The first step in the calculation of one's Social Security benefit is the determination of the Primary Insurance Amount (PIA). The PIA, which equals the size of the benefit that an individual receives when he or she claims benefits at the full retirement age, is an increasing and concave function of average earnings over the working career. In other words, the replacement rate (of Social Security) falls nonlinearly with the average level of lifetime earnings. The PIA is then adjusted on the basis of the age at which benefits are claimed. Individuals qualify for a benefit by working for at least forty quarters in covered employment, which encompasses most sectors of the economy in the meantime. Exceptions are some state and local employees. So, in contrast to public pensions in most other countries, job history plays an important role here. The self-employed can also qualify for a benefit by paying Social Security taxes.

Although the average replacement rate of Social Security is around 40 percent, there are large differences between income groups. For example, an individual who has worked for forty years, has average earnings of $20,000, and retires at the age of 65, will have a Social Security replacement rate of around 70 percent (i.e., he or she will receive a benefit of $14,000), while an individual who also has worked for forty years and retires at the age of 65 as well but with average earnings of $150,000, will have a replacement rate of only 11 percent.

Receiving Social Security retirement benefits is subject to an earnings test at the individual level. If someone who is eligible for Social Security earns more than a certain floor level, Social Security benefits are reduced proportionately. In principle, spouses of Social Security beneficiaries are entitled to a benefit of 50 percent of the PIA, even if they have never worked. However, spouses only receive the larger of this amount and their own entitlement. Also, dependent children are eligible for a benefit of 50 percent of the PIA, but the total family benefit can not exceed an amount of about 175 percent of the PIA.

In addition to the retirement program, Social Security consists of the Supplemental Social Security Income (SSI) program that provides income to the low-income elderly and disabled individuals. An asset test is required for participation in this program. For example, in 2012 an individual must have assets less than $2000 and couples must have less than $3000 to get SSI. The program ensures a guaranteed income for all eligible individuals, which is just below the poverty line. Due to income disregards and supplemental benefits offered by states, income rises above the poverty line for a small subset of SSI recipients. However, for most recipients income is below the poverty line.

### 3.2.2 Second pillar: Employer-provided pension schemes and 401(k) plans

For most individuals the replacement rate of Social Security, on average around 40 percent, is too low to maintain their pre-retirement standard of living, so they participate in (non-mandatory) employer-provided pension schemes or 401(k) plans as well. Employer-provided pension plans can be either defined contribution or defined benefit. The majority of workers in the United States is now covered by a defined contribution plan.[4] The vast majority of workers with a defined benefit plan is working in the public sector. In addition, since the end of the 1980s the amount of ”hybrid” plans has been rising steadily. These plans offer a combination of defined benefit and defined contribution elements.

401(k) are tax-deferred defined contribution plans. In 2013, the maximum annual contribution is $17,500. The contribution limit is increased every now and then by taking inflation into account. Depending on the plan's specifications part of the contribution may be matched by the employer. 401(k) withdrawals are taxable as ordinary income. With a few exceptions, an individual is allowed to start withdrawing at age 59 12. If you start before this age an early distribution penalty tax will be imposed. It is allowed to delay receiving until April 1 of the year following the year in which you reach the age of 70 12. Note that for the employee, participation in 401(k) plans as well as traditional employer-provided pension plans is voluntary, although a large majority of workers participates. At this moment, around 75 percent of eligible employees participate in a 401(k) plan. Since the introduction of 401(k) in 1981 it is more and more supplanting traditional employer-provided pension plans.

### 3.2.3 Third pillar: IRAs and other annuities

If individuals want to save for retirement beyond Social Security, employer-provided pension plans and 401(k), there are several types of IRAs available. The most common types of IRA are Traditional IRAs and Roth IRAs. Traditional IRAs exist since 1981 and allow tax-deductible contributions for individuals. However, withdraw-

[4] In 2005, 70 percent of workers had a defined contribution plan, and 30 percent had a defined benefit plan (Broadbent et al., 2006).

als from Traditional IRAs are taxable. On the other hand, contributions to Roth IRAs are non-deductible, but none of the withdrawals from Roth IRAs is taxed if you withdraw after at least five years and at a minimum age of 59 12. You can make contributions until the age of 70 12.

The main difference between a 401(k) plan and an IRA is that a 401(k) plan is offered by the employer, who matches the contributions in some cases, while an IRA has nothing to do with your job. It simply is a private investment solely by your own money.

In 2010, 39.5 percent of income of elderly Americans (age 65 and over) came from Social Security (first pillar), 19.7 percent came from pension plans and annuities, 11.8 percent from income from assets, 26.9 percent from earnings, and 2.1 percent from other sources.[5] As the category *pension plans and annuities* also encompasses savings in the third pillar to the extent that retirement wealth is annuitized, the second and third pillar are quite comparable in size.

## 3.3 Calculating Replacement Rates

We use the RAND HRS data file, which contains cleaned and processed variables, model-based imputations, and spousal counterparts of most individual-level variables. The RAND HRS data file is derived from the HRS, a longitudinal household survey data set for the study of health and retirement of the elderly in the United States. We use all ten waves (1992-2010) of the RAND HRS data file. The data file contains data on demographics and family structure, health, income, social security and pensions, wealth, and employment history. Almost all variables are defined at the level of the individual. The only exception are the wealth variables, which are defined at the level of the household. As it is impossible to assign wealth to individual household members, the household will be our unit of analysis throughout this whole study.

We are not able to calculate a replacement rate for each household. There are several reasons for this. The most important is insufficient information about income before as well as after retirement. If we observe a household only before retirement, or alternatively, only after retirement, it is impossible to calculate a replacement rate. So, at the very minimum we have to observe a household at least two times, once before retirement and once after retirement, in order to be able to calculate a replacement rate. In addition, for some households the timing of re-

[5] See http://www.ebri.org/pdf/publications/books/databook/DB.Chapter%2007.pdf.

tirement is very unclear. Table 3.1 provides information about the evolution of the number of observations in each step of the calculation process. In the last step, where we drop all households for which we are unable to calculate a replacement rate, we lose around 80% of all households. This is caused by the strict criteria that we use to classify households as either ”working” or ”retired”. Below we explain exactly what we do and why we choose these criteria.

Table 3.1. *Evolution of number of observations*

| Operation | Obs. lost | Level | Obs. left | Hh's left |
|---|---|---|---|---|
| *Original RAND HRS cohort* | | Indiv.-Year | 135,250 | |
| Couple household becomes single household | 10,741 | Indiv.-Year | 124,509 | |
| Households with more than two adults | 8,011 | Indiv.-Year | 116,498 | |
| Missing birth year | 10 | Indiv.-Year | 116,488 | |
| Transformation individuals to households | 43,600 | | 72,888 | 7,598 |
| Non-respondents in particular wave | 22,493 | H.h.-Year | 50,395 | 7,388 |
| Age $< 51$ or $> 79$ | 3,693 | H.h.-Year | 46,702 | 7,181 |
| Household head self-employed | 5,329 | H.h.-Year | 41,373 | 6,897 |
| Insufficient information about income to calculate the replacement rate | 30,791 | H.h.-Year | 10,582 | 1,204 |

As table 3.1 reveals, a large group that we drop (apart from dropping the households that are not part of the HRS cohort[6]) consists of couple households that become single households, either through divorce or death of one of the household members. The reason for not using these households is that it is very difficult to aggregate the individual data into household data for this group. For example, we have to define a birth year for the household. This is the birth year of the household head, as defined by us. If the household head would die, however, the remaining spouse would become household head and the birth year of the household head would most likely change. This makes it impossible to study the evolution of wealth over the lifecycle. Furtermore, in some cases we would observe a large drop in income after one of the household members deceases.

However, dropping a household from the moment that one of the members passes away could introduce bias in the estimates of our wealth model (see chapter 4). There exists a positive correlation between wealth levels and life expectancy

[6] The Health and Retirement Study consists of several cohorts: AHEAD (born before 1924), CODA (Children of Depression) (born 1924-1930), HRS (born 1931-1941), WB (War Baby) (born 1942-1947), and EBB (Early Baby Boomers) (born 1948-1953). Our study only uses households from the HRS cohort as the probability of observing them before as well as after retirement is highest for this cohort.

(Hurd, 1990). Therefore, wealthy households might be overrepresented in our sample, especially in the oldest age categories. To examine the extent of this selection problem we present median wealth levels by age category, for the full HRS cohort (households where the household head is born between 1931 and 1941) and for our sample, in table 3.2.

Table 3.2. *Median financial net wealth (FNW) and total net wealth (TNW) per age category for our sample and for the full HRS cohort (1992 dollars)*

| | **FNW** | | | | **TNW** | | | |
|---|---|---|---|---|---|---|---|---|
| Age | Obs. | Sample | Obs. | HRS Coh. | Obs. | Sample | Obs. | HRS Coh. |
| 51-55 | 1,174 | 30,398 | 7,955 | 31,326 | 976 | 79,487 | 6,628 | 85,543 |
| 56-59 | 1,866 | 34,221 | 9,514 | 31,279 | 1,448 | 94,605 | 7,874 | 93,791 |
| 60-63 | 2,184 | 38,473 | 11,027 | 33,119 | 1,807 | 101,275 | 9,511 | 100,000 |
| 64-67 | 2,167 | 39,903 | 10,569 | 36,027 | 2,045 | 116,191 | 9,551 | 112,606 |
| 68-71 | 1,854 | 30,967 | 8,617 | 32,330 | 1,854 | 108,577 | 8,243 | 109,031 |
| 72-75 | 1,003 | 23,279 | 5,556 | 29,046 | 1,003 | 97,137 | 5,468 | 110,003 |
| 76-79 | 334 | 18,083 | 2,742 | 30,597 | 334 | 84,785 | 2,703 | 114,548 |
| Total | 10,582 | 33,923 | 55,980 | 32,501 | 9,467 | 102,327 | 49,978 | 100,496 |

Notes: *The exact definitions of FNW and TNW are given in chapter 4 of this thesis. The full samples (55,980 and 49,978 observations) are obtained by dropping all households of which the household head is younger than 51 or older than 79 from the original RAND HRS cohort (135,250 individual-level observations, see table 3.1) and transforming the individual data into household data.*

As can be seen in table 3.2, median wealth of our sample is comparable to median wealth in the full HRS cohort for households younger than 72 years old. However, for households older than 72, our sample contains less wealthy households than the full HRS cohort. This is exactly opposite to what one would expect by dropping all households with a non-constant number of household members. However, there is another possible explanation for this. Single households are overrepresented in our sample, because it is easier to calculate a replacement rate for single households than for couple households. Wealth levels of single households will, on average, be lower than wealth levels of couple households. This might explain the bias towards less wealthy households in the oldest age categories. A Wilcoxon-Mann-Whitney test reveals that median financial wealth as well as median total wealth in our sample are not significantly different from the full HRS cohort ($p$-values of the tests are 0.69 and 0.16).

We calculate the replacement rate for each household as follows: after collapsing the wealth and income data by household, we determine for each wave of the data whether a particular household is working, retired, or whether its status is unclear. To be labeled as ”working”, households have to meet the following criteria:

1) the household head[7] has to report a "no retirement status" in the survey (variable *rretemp* in the RAND HRS), 2) he or she has to report to be "currently working for pay" (variable *rwork*), 3) household before-tax earnings from labor have to be higher than before-tax pension income, 4) total hours worked per week (of the household member who works most hours per week) have to be at least 30, and 5) all household members have to be younger than 65. On the other hand, households are labeled as "retired" if i) the household head reports an "only retired status", ii) total hours worked per week are equal to zero for the whole household, and iii) all household members are at least 65 years old. An unclear status mainly reflects situations such as partial retirement, or a large age difference between household members.

We impose that labor earnings have to be higher than pension income (criterion 3) and a minimum of 30 hours worked per week (criterion 4) to prevent that households where the household head is partially retired are classified as "working". In the same way, the restriction that none of the household members is working anymore (criterion ii) is to make sure that all household members are fully retired when the household is classified as "retired". These criteria are necessary to obtain an accurate replacement rate measure.

The next step is to calculate average earnings[8] for the years when a household is considered as "working", and to calculate average pension income for the "retired" years. Pension income consists of Social Security retirement benefits, Supplemental Social Security Income, employer-provided pension plans and 401(k) plans. Other savings (such as those in IRAs) are considered as discretionary savings and thus not part of pension income. We obtain the replacement rate $RR$ by dividing average pension income $Y^{pens}$ by average earnings $Y^{earn}$: $RR = \frac{Y^{pens}}{Y^{earn}}$. Note that this is a gross replacement rate, because we observe all income amounts before taxes. Furthermore, all monetary amounts are in real terms (constant 1992 dollars).

We distinguish between the replacement rate from Social Security only, the first pillar replacement rate $RR_{FP}$, and the replacement rate from Social Security, employer-provided pensions, and 401(k) together, the overall replacement rate $RR_O$. First pillar pensions consist of Social Security retirement (variable *risret*) and Supplemental Security Income (variable *rissi*). Employer-provided pensions and 401(k)

[7] We define the household head (in case of a couple household) to be the man. In case of a same sex couple, the older member is the household head. As we study households whose members are born between 1931 and 1941, it is not unreasonable to assume that traditional male-female patterns still exist for these cohorts. However, see Kleinjans (2010) for a discussion of this issue.

[8] Earnings consist of earnings from labor (*riearn*), Social Security disabilty benefits (*risdi*), unemployment or workers compensation (*riunwc*), and other government transfers (*rigxfr*).

plans (variable *ripena*) form second pillar pensions. Note that we can not distinguish between employer-provided pensions and 401(k) plans. Social Security is the only component of retirement income that is fully mandatory. Employer-provided pensions and 401(k) are voluntary pension schemes, although a large fraction of U.S. workers participates in them.

Our calculation method uses an average of earnings in the last few years before retirement. We do not take final earnings to limit the effect of measurement error. However, by ignoring earnings in the earlier stages of the lifecycle we might underestimate the replacement rate. Our decision to use this method is driven by data considerations; we simply do not have information about earnings before the age of 51.

Table 3.3 presents summary statistics for both replacement rate measures and its components. Each household has to be working in at least one wave and to be retired in at least one wave in order to calculate its replacement rate. As we study the HRS cohort of the RAND HRS data file, which consists of individuals born between 1931 and 1941, this is the case for a large group of households. Because we use the first ten waves (1992-2010) of the RAND HRS data file the age of survey participants ranges from 51 until 79 years old. Eventually we are able to calculate the replacement rate for 1,204 households. It is important to emphasize that our measure of the household replacement rate is time-invariant. The median replacement rates are 0.333 and 0.485. This seems quite low, but note that these are gross (before-tax) replacement rates. The net replacement rates will be higher.

Table 3.3. *Summary statistics first pillar replacement rate ($RR_{FP}$) and overall replacement rate ($RR_O$) and its components*

| Variable | Obs. | Hh's | Mean | St.dev. | Q1 | Median | Q3 |
|---|---|---|---|---|---|---|---|
| $RR_{FP}$ | 1,204 | 1,204 | 0.457 | 1.788 | 0.242 | 0.333 | 0.448 |
| $RR_O$ | 1,204 | 1,204 | 0.637 | 1.802 | 0.357 | 0.485 | 0.667 |
| Total Income | 10,582 | 1,204 | 36,531 | 33,642 | 15,816 | 28,416 | 48,000 |
| Income before retirement | 3,340 | 1,204 | 38,075 | 28,514 | 18,200 | 30,994 | 50,223 |
| Income after retirement | 2,967 | 1,204 | 18,411 | 17,736 | 8,291 | 14,480 | 23,446 |
| Social Security Income | 2,967 | 1,204 | 10,537 | 5,721 | 6,533 | 9,502 | 14,400 |
| non-zero S.S. Income | 2,872 | 1,181 | 10,886 | 5,478 | 6,893 | 9,760 | 14,597 |
| Other Pension Income | 2,967 | 1,204 | 7,874 | 16,128 | 0 | 2,448 | 10,620 |
| non-zero Pension Income | 1,733 | 779 | 13,481 | 19,230 | 4,032 | 8,595 | 16,989 |

Note: *All monetary amounts are in constant 1992 dollars.*

Income after retirement consists of Social Security Income and Other Pension

Income. On average, around 80% of Income after retirement consists of Social Security Income. However, if we only consider observations with non-zero Social Security Income and Other Pension Income, median Social Security Income is only a fraction higher than Other Pension Income. Whereas only 95 observations have zero Social Security Income, 1,234 observations have zero Other Pension Income. This is around 40% of the observations. Finally, Income before retirement is more than twice as high as Income after retirement, which reflects the relatively low replacement rates that the U.S. pension system delivers.

Table 3.4 presents summary statistics for the replacement rate per level of educational attainment, where we use the level of education of the household head. The variable *raeduc* in the HRS can take on values from one to five. We construct four levels of educational attainment: ”elementary”, ”secondary”, ”college”, and ”university”. If the level of educational attainment is non-constant within households, we take the mode.

Table 3.4. *Replacement Rates and Educational Attainment*

| | $RR_{FP}$ | | | | $RR_O$ | | | |
|---|---|---|---|---|---|---|---|---|
| Level of Education | **elem** | **sec** | **coll** | **uni** | **elem** | **sec** | **coll** | **uni** |
| Observations | 274 | 443 | 263 | 224 | 274 | 443 | 263 | 224 |
| Mean | 0.746 | 0.393 | 0.429 | 0.264 | 0.846 | 0.543 | 0.618 | 0.590 |
| Standard Deviation | 3.534 | 0.244 | 1.178 | 0.233 | 3.528 | 0.385 | 1.188 | 0.496 |
| $10^{th}$ Percentile | 0.219 | 0.195 | 0.147 | 0.045 | 0.267 | 0.282 | 0.255 | 0.201 |
| $25^{th}$ Percentile | 0.307 | 0.265 | 0.227 | 0.165 | 0.387 | 0.369 | 0.337 | 0.332 |
| Median | 0.413 | 0.355 | 0.319 | 0.242 | 0.517 | 0.473 | 0.471 | 0.482 |
| $75^{th}$ Percentile | 0.589 | 0.463 | 0.416 | 0.325 | 0.728 | 0.640 | 0.656 | 0.713 |
| $90^{th}$ Percentile | 0.875 | 0.622 | 0.525 | 0.426 | 1.000 | 0.823 | 0.844 | 0.906 |
| $p$-value median test | 0.000 | | | | 0.279 | | | |

Note: *If the HRS variable* raeduc *is 1 or 2 (Lt-High School or GED) educational attainment is classified as* elementary*, if it is 3 (High-school graduate) as* secondary*, if it is 4 (Some college) as* college*, and if it is 5 (College and above) as* university*.*

As Hurd et al. (2012) note, the level of education is a strong predictor of lifetime earnings. Also, Social Security benefits are an increasing but concave function of income, which implies that $RR_{FP}$ is decreasing in income. Combining these two facts predicts that the replacement rate is decreasing in educational attainment. In addition, the higher one’s education, the later the working career starts, on average, which has a negative effect on the accumulation of second pillar pension wealth.

Table 3.4 shows that the median $RR_{FP}$ is significantly decreasing in educational attainment. $RR_O$ is also decreasing in educational attainment, although a median test shows that these differences are not significant. Apparently, the second pillar largely undoes the distributional effects of the first pillar. As a large component of the second pillar consists of voluntary pension arrangements, especially highly-educated households thus seem to make a deliberate choice in using second pillar pensions to bridge the gap that Social Security creates for them.

Figure 3.1 plots permanent income[9] against $RR_{FP}$. The relationship is negative and non-linear, as Social Security income (in levels) is an increasing and concave function of average earnings. Figure 3.2 shows the relationship between permanent income and $RR_O$. At first sight, this relationship seems to be weak, which is again an indication that the redistribution that Social Security achieves is largely undone by the second pillar of the pension system.

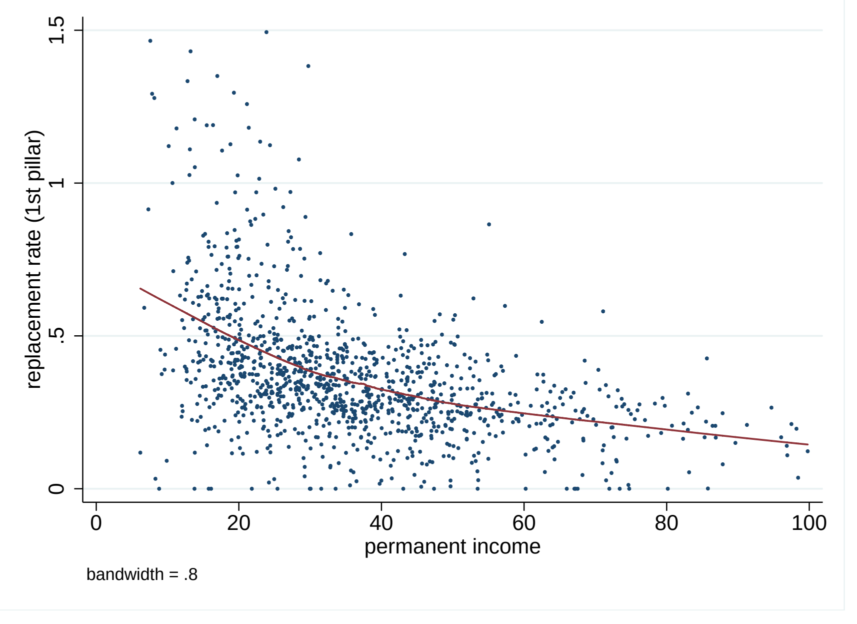


Figure 3.1. Correlation beween permanent income (in \$1000) and $RR_{FP}$. The regression line is obtained by a locally weighted regression (Stata command *lowess*) of $RR_{FP}$ on permanent income.

[9] The appendix contains a detailed description of the calculation method of permanent income.

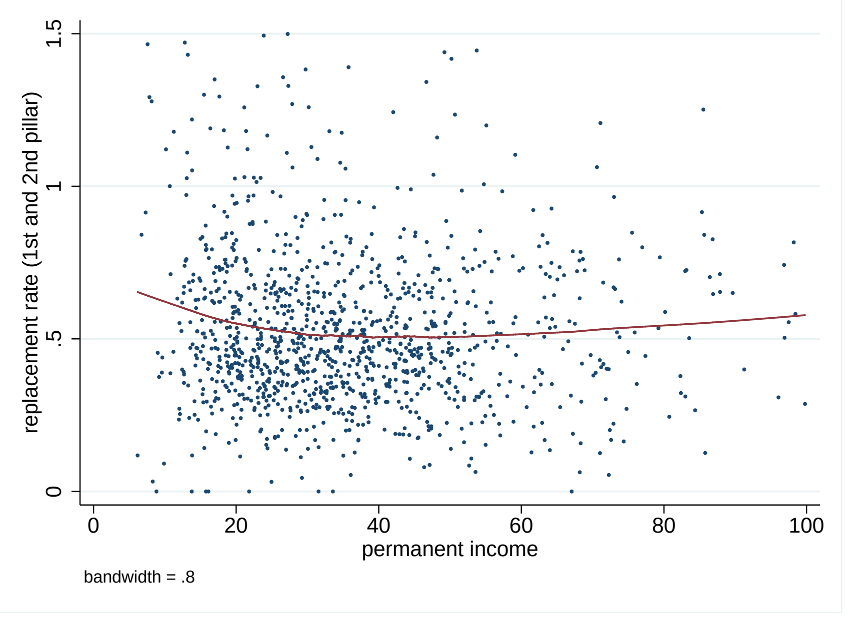


Figure 3.2. Correlation beween permanent income (in $1000) and $RR_O$. The regression line is obtained by a locally weighted regression (Stata command *lowess*) of $RR_O$ on permanent income.

## 3.4 Which Variables are Correlated with the Replacement Rate?

Table 3.5 presents OLS estimates of regressing the (log) replacement rate on some variables that might be correlated with it. The first two columns show the results for $RR_{FP}$, and the last two columns for $RR_O$. The number of observations varies slightly between the different columns due to a few missing observations for the expected age of retirement and $RR_{FP}$. We apply a logarithmic transformation to the replacement rate and to permanent income, so that this regression coefficient can be interpreted as an elasticity.

As the replacement rate is a time-invariant variable, possibly correlated variables should be time-invariant as well. Only for the region dummies we have taken the mode, although the within-household variation is very small.

As can be seen in the first two columns of table 3.5 Social Security replacement rates ($RR_{FP}$) are higher for younger generations, by approximately 1% per year of birth. This is in line with the observation that pre-tax Social Security benefit levels are steadily rising, due to the fact that benefits are pegged to wage inflation instead of price inflation. On the other hand, $RR_O$ is around 1% per year of birth lower for younger generations. One of the causes of this finding could be that employer-provided pension plans have become less generous the last two decades.

In these regressions, the level of education is not correlated with the replacement rate. Furthermore, as we have seen before, the relationship between permanent income and $RR_{FP}$ is strongly negative. The elasticity of $RR_{FP}$ with respect to permanent income is around -0.6. Based on the regression results in the last two columns, $RR_O$ is at its minimum around a permanent income level of $40,000 ($42,000 based on the results in the last column). Apparently, households with permanent income above $40,000 use employer-provided pension plans and 401(k) to more than compensate the negative relationship between income and Social Security benefit levels. In addition, the difference between single and couple households is insignificant. This is in line with the numbers that Munnell and Soto (2005) report.

We also examine the effect of the expected age of retirement and the actual age of retirement on the replacement rate. Although it is very difficult to determine the exact retirement age, especially because partial retirement plays an important role in the U.S., we use the variable *rretemp* of the HRS to determine the labor market status of each household[10] in every wave. While both the expected and the actual age of retirement have a positive effect on $RR_{FP}$, they do not influence $RR_O$. For each year that retirement is postponed $RR_{FP}$ increases by approximately 2 to 3%.

Finally, while the education and sector dummies are jointly insignificant, the region dummies are jointly significant. In other words, there are statistically significant differences in replacement rates between census regions. This might be related to the following: Munnell et al. (2008) show that there are considerable differences in labor participation rates of men aged 55-64 across states and census regions. Also, Coile and Gruber (2007) report that early retirement is significantly more prevalent in the Pacific region, and significantly less in New England, compared to the other regions of the country. Early retirement will, ceteris paribus, decrease the replacement rate, as workers simply have had less time to accumulate pension savings. Also, Social Security benefits are lower when they are claimed before the official retirement age. In chapter 4 we will exploit these differences between census regions in an instrumental variables approach.

[10] To be more precise, *rretemp* gives the labor market status of the household head. We admit that this might be misleading, but think that it is a good approximation as the household head will in most cases be the person with the highest salary.

Table 3.5. *OLS Regression Estimates*

| *Dependent variable* | $\log(RR_{FP})$ | | $\log(RR_O)$ | |
|---|---|---|---|---|
| Year of birth | 0.010 | 0.009 | -0.011 | -0.014 |
| | (0.005)* | (0.005)* | (0.005)** | (0.005)*** |
| Secondary education | 0.023 | 0.017 | -0.009 | -0.026 |
| | (0.042) | (0.042) | (0.043) | (0.042) |
| College education | 0.029 | 0.053 | -0.052 | -0.041 |
| | (0.058) | (0.059) | (0.057) | (0.058) |
| University education | -0.120 | -0.083 | -0.054 | -0.058 |
| | (0.075) | (0.073) | (0.068) | (0.067) |
| Log permanent income ($1000) | -0.587 | -0.621 | -1.572 | -1.749 |
| | (0.057)*** | (0.061)*** | (0.511)*** | (0.551)*** |
| (Log permanent income)$^2$ | | | 0.213 | 0.234 |
| | | | (0.072)*** | (0.077)*** |
| Couple household | -0.032 | -0.057 | -0.032 | -0.008 |
| | (0.040) | (0.038) | (0.036) | (0.035) |
| Expected age of retirement | 0.030 | | -0.004 | |
| | (0.006)*** | | (0.005) | |
| Actual age of retirement | | 0.021 | | -0.005 |
| | | (0.005)*** | | (0.004) |
| $p$-value $\chi^2$-test joint sign. education dummies | 0.135 | 0.228 | 0.758 | 0.845 |
| $p$-value $\chi^2$-test joint sign. sector dummies | 0.128 | 0.138 | 0.564 | 0.446 |
| $p$-value $\chi^2$-test joint sign. region dummies | 0.006 | 0.005 | 0.002 | 0.007 |
| Number of observations | 1,087 | 1,181 | 1,101 | 1,196 |
| $R^2$ | 0.27 | 0.27 | 0.07 | 0.07 |

Notes: *Numbers in parentheses are robust standard errors. *,**,*** denote significance at the 10%, 5% and 1% respectively. We estimated the regressions of the first two columns with (Log permanent income)$^2$ as well, but the coefficient estimates turned out to be insignificant. Therefore, in order to be able to interpret the elasticity of $RR_{FP}$ with respect to permanent income we excluded the quadratic term in the first two columns. All specifications include a full set of sector dummies and region dummies.*

## 3.5 Conclusions

The main contribution of this chapter is that we calculate replacement rates of households using the HRS. In addition, we show which factors correlate with the replacement rate of households. It is important to emphasize that we show correlations, not causations. For example, unobserved factors that both influence the replacement rate and the level of income might cause the correlations that we find between permanent income and the replacement rate.

Our main findings are that $RR_{FP}$ is higher for younger cohorts, while $RR_O$ is lower, and that the replacement rate is decreasing in educational attainment and permanent income. Note that this chapter intends to be mainly descriptive, not explanatory.

In the next chapter of this thesis we will relate the replacement rate of households to their saving behavior. More specifically, we will test the hypothesis that the lower the replacement rate of households the more they will save for retirement.

## 3.A Appendix

In this appendix we describe how we calculate permanent income for each household. First, we perform a fixed effects regression of (log) income $y_{ht}$ on age dummies $age_a$, time effects $\gamma_t^*$, and a dummy $d_{ht}$ for couple households. Note that the coefficients of this regression model are not fully identified due to the identity age + year of birth = time. Therefore, we assume that the time effects sum up to zero and are orthogonal to a time trend (see Deaton and Paxson (1994)). This also implies that the time effects are modeled as pure business cycle effects and can be ignored in predicting income. This approach largely follows the model of Kapteyn et al. (2005):

$$\log(y_{ht}) = \sum_{a=51}^{79} \phi_a age_a + \gamma_t^* + \beta\, d_{ht} + u_h + \epsilon_{ht}. \tag{3.A.1}$$

Figure 3.A.1 presents age-income profiles for four different levels of educational attainment, based on the regression results.

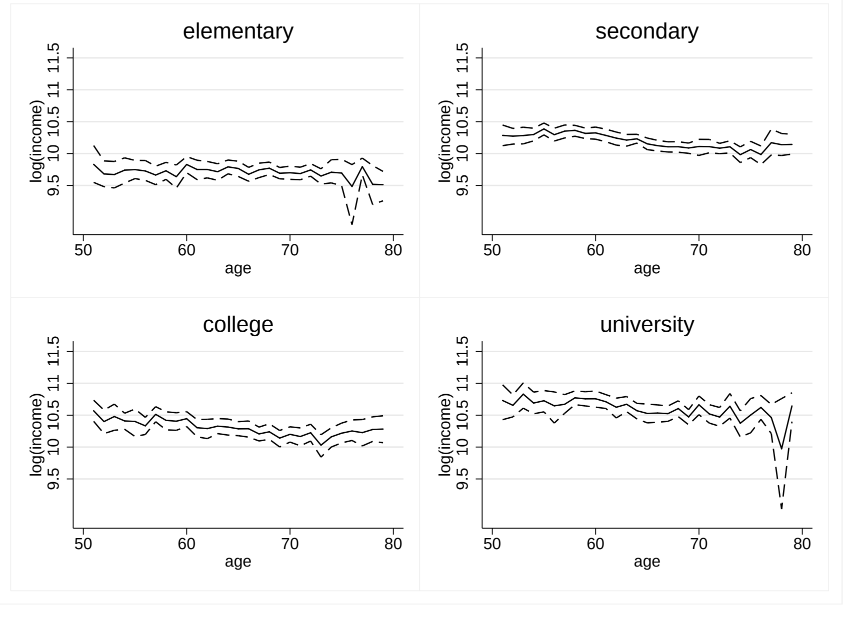


Figure 3.A.1. Age-log(income) profiles (solid lines) for four levels of educational attainment. The dashed lines represent 95% confidence bounds, based on 1000 bootstrap replications (clustered at the household level).

If the HRS variable *raeduc* is 1 or 2 (Lt-High School or GED) educational attainment is classified as *elementary*, if it is 3 (High-school graduate) as *secondary*, if it is 4 (Some college) as *college*, and if it is 5 (College and above) as *university*.

As expected, income is increasing in educational attainment. Furthermore, the drop in income is higher for college- and university-educated households than for elementary- and secondary-educated households. This is in line with the observation that replacement rates are decreasing in educational attainment.

The next step is to predict past and future incomes, based on the regression results from estimating equation 3.A.1. We assume that education level is time-invariant, when we backcast and forecast income. Furthermore, we set all time dummies to zero, as we have modeled them as pure business cycle effects.

We want to take into account that household characteristics might change if people age. We therefore estimate the following fixed effects regression model and use the coefficient estimates to predict how the probability of having a partner changes when the household ages:

$$d_{ht} = \mu_h + \sum_{a=51}^{79} \phi_a age_a + u_{ht},$$

where $d_{ht}$ is the presence of a partner of household $h$ in year $t$, $\mu_h$ is a household fixed effect, $age_a$ is an age dummy for age $a$ and $u_{ht}$ is a random i.i.d. error term with mean zero and variance $\sigma_u^2$. Note that we assume that income is constant until the age of 51. We have to make this assumption as we only have data for households in the age of 51 to 79. Finally, we predict past, current, and future income of households for which income data is missing, by assuming that the individual effect equals zero for them.

Then, permanent income in year $t$ equals:

$$Y_h^P = \frac{W_{h0} + \sum_{\tau=0}^{T}(1+r)^{-\tau}\hat{y}_{h\tau}}{\sum_{\tau=0}^{T}(1+r)^{-\tau}},$$

where $\hat{y}_{h\tau}$ is the predicted value of $y_{h\tau}$. This equation states that permanent income is a weighted average of the present values of all past, current, and future incomes, where the discount factors form the weights. In case all incomes would be exactly equal to each other, these would also be equal to permanent income. One of the simplifications that we make is that we set wealth at the age of 20, $W_{h0}$, equal to zero. We assume that the interest rate $r$ is fixed and equal to 3%. Furthermore, we only calculate future income until the age of 80 and assume that it is zero afterwards (or equivalently, that people die at the age of 80). This means that $T$ equals 59 in the equation above. The effect of taking survival probabilities into account will be negligible, so we choose to ignore them to keep things as simple as possible.

*Chapter 4*

# Retirement replacement rates and saving behavior

## 4.1 Introduction

Several studies (Mitchell and Moore, 1998, Wolff, 2002, Skinner, 2007) claim that U.S. households are not saving enough for retirement. Madrian and Shea (2001) show that behavioral explanations might be at the root of so-called "default" behavior with respect to saving for retirement, which could lead to the inadequacy of retirement savings. However, other studies (Engen et al., 1999, Scholz et al., 2006) suggest that the problem is less severe. In light of these issues it is useful to examine the saving response of households to differences in the generosity of their pension schemes.

A simple version of the life cycle model (Modigliani and Brumberg, 1954, Friedman, 1957) implies that, if income follows a hump-shaped profile over the life cycle, households will save when they are young and dissave when they are old. The larger the gap between income before and after retirement, the more households need to save in order to maintain a reasonable standard of living when retired. The retirement replacement rate[1] provides a measure of this gap; it is the ratio between income after retirement and income before retirement.

There is a large amount of studies about the displacement effect of pensions on nonpension wealth. Among them are the seminal contributions by Feldstein (1974, 1996) and Gale (1998). The main question in this literature is whether pension

[1] For the sake of brevity we will refer to the replacement rate instead of the retirement replacement rate throughout the rest of this chapter.

wealth crowds out nonpension wealth. Estimates of this displacement effect range from close to zero (no crowding out) to close to minus one (full crowding out).

Related to this, we study whether the replacement rate affects households' saving behavior, and in particular whether age-wealth profiles are affected by the replacement rate of households. So, unlike the displacement literature, we do not use pension wealth but replacement rates. One of the main differences between the displacement literature and our approach is that we follow households over time, whereas most studies that estimate the displacement effect rely on cross-sectional household data.

Although some recent chapters (see, for example, Engelhardt and Kumar (2011)) use administrative data to calculate pension wealth, most chapters in the displacement literature use survey data. To calculate pension wealth from survey data requires many assumptions. To calculate replacement rates we only need to observe income before retirement, and income after retirement. The drawback, on the other hand, of our approach is that we are not able to accurately calculate a displacement effect between -1 and 1. Nonetheless, we are able to test the most important implications of the life cycle model.

Somewhat related to the subject of our study is the work by Bernheim et al. (2001), who are unable to find an effect of differences in replacement rates on wealth accumulation, although they do not use direct wealth data but instead derive it from income and consumption data. They argue that saving behavior of households is more consistent with "rule of thumb", "mental accounting", or hyperbolic discounting theories of wealth accumulation (see, for example, Laibson (1997)), than with the life cycle model[2]. As there have been many adaptations, extensions, and alternatives proposed to the life cycle model (for an overview, see Attanasio and Weber (2010)), it is interesting to study whether this particular implication of the model holds up in the raw data.

Hurd et al. (2012) construct replacement rates by education level and marital status for groups of households in several OECD countries and use these to estimate the effect of the generosity of public pensions on saving rates. Note that they do not calculate replacement rates for individual households and only consider public pensions. Our primary innovation is to calculate replacement rates for public and private pensions of individual households from the Health and Retirement Study (HRS) cohort of the RAND HRS data file, and use these to test the effect of the replacement rate on households' saving behavior. We exploit the panel structure of

[2] See Akerlof (1991), Thaler (1994), and Lusardi (1999) for other behavioral explanations of saving behavior.

the data to observe labor income as well as pension income for a group of households, which allows us to calculate (before-tax) replacement rates.

The replacement rate suffers from the same endogeneity problems as pension wealth (see, for example, Engelhardt and Kumar (2011)). Most notably, measurement error and unobserved heterogeneity in household saving behavior might cause correlation between the replacement rate and the error term in a regression of wealth on the replacement rate. Also, the level of nonpension wealth could influence the replacement rate if the timing of retirement depends on the amount of wealth accumulated, in which case correlation between the replacement rate and the error term is caused by simultaneity.

To overcome the endogeneity problem we use an instrumental variables approach. In addition, as the distribution of wealth is heavily skewed to the right and influential outliers might be present, we estimate quantile regressions. To combine an instrumental variables approach with quantile regressions we use the Instrumental Variable Quantile Regressions (IVQR) estimator, proposed by Chernozhukov and Hansen (2008). This estimator has been used before by, among others, Engelhardt and Kumar (2011) and Alessie et al. (2013). In addition, we split our sample in four subsamples, defined by the four quartiles of the replacement rate distribution, to investigate whether there are differences in age-wealth profiles between groups with different replacement rates.

We construct an instrument for the replacement rate based on the census region of the household, and the employment sector in which the particular household head has had his or her job with longest job tenure. For example, for a household from census region Midwest, where the household head worked for most of his or her career in the public sector, the value of the instrument is the average replacement rate for households from the Midwest who worked in the public sector. As long as workers do not sort across sectors or move to another census region in response to differences in replacement rates, an assumption which is quite common (Attanasio and Brugiavini, 2003, Engelhardt and Kumar, 2011), our instrument exploits exogenous variation in the replacement rate.

To examine the effects of the replacement rate on saving behavior we estimate a regression model with the ratio of wealth to permanent income as dependent variable, and age dummies and the replacement rate as main independent variables. Our hypothesis is that the lower their replacement rate the more households will save for retirement, relative to permanent income. In addition, households with a relatively low replacement rate will dissave more after retirement. In other words, the lower the replacement rate the steeper the age-wealth profile of households. We assume that households have full certainty about their replacement rate at the time of making saving decisions, as they are at most 15 years from retirement[3]. Note that this hypothesis is in line with the life cycle model as well as with mental accounting models.

We have three main findings. First, based on IV regressions we are unable to conclude that the amount of financial wealth that households have accumulated around the age of 65, relative to permanent income, is decreasing in the replacement rate. Second, the age-wealth profile of households in the highest quartile of the replacement rate-distribution is very flat. Their saving rate is very low and constant over the lifecycle. Finally, households hardly decumulate wealth after retirement and some groups even keep saving after retirement.

The remainder of this chapter is organized as follows. Section 2 describes the data that we use. Section 3 discusses our method of identification and presents the empirical model. Section 4 presents results, and finally, Section 5 concludes.

## 4.2 Data

In this section we describe the data that we use. First, we discuss the replacement rate. Second, we present the other variables that we use in our analysis. We use the RAND HRS data file, which contains cleaned and processed variables, model-based imputations, and spousal counterparts of most individual-level variables. The RAND HRS data file is derived from the HRS, a longitudinal household survey data set for the study of health and retirement of the elderly in the United States. We use all ten waves (1992-2010) of the RAND HRS data file. The data file contains data on demographics and family structure, health, income, social security and pensions, wealth, and employment history. Almost all variables are defined at the level of the individual. The only exception are the wealth variables, which are defined at the level of the household. As it is impossible to assign wealth to individual household members, the household will be our unit of analysis throughout this whole study.

Descriptive statistics of the replacement rate are shown in table 4.1. Chapter 3 of this thesis contains a detailed description of the calculation method of two replacement rate measures. It also presents a table that clarifies our data selections. We

[3] The HRS cohort consists of households with at least one person in the household born between 1931 and 1941, who is between 51 and 79 years old during the sample period.

present summary statistics for the first pillar replacement rate $RR_{FP}$ and the overall replacement rate $RR_O$. The first pillar contains Social Security and the second pillar consists of employer-provided pensions and 401(k). Note that the replacement rate is time-invariant, which explains the number of 1,204 observations (one for each household).

Table 4.1. *Summary statistics of the first pillar replacement rate ($RR_{FP}$) and the overall replacement rate ($RR_O$)*

| | $RR_{FP}$ | $RR_O$ |
|---|---|---|
| Observations | 1,204 | 1,204 |
| Mean | 0.457 | 0.637 |
| Standard Deviation | 1.788 | 1.802 |
| $10^{th}$ Percentile | 0.151 | 0.259 |
| $25^{th}$ Percentile | 0.242 | 0.357 |
| $50^{th}$ Percentile (Median) | 0.333 | 0.485 |
| $75^{th}$ Percentile | 0.448 | 0.667 |
| $90^{th}$ Percentile | 0.632 | 0.883 |

Note: *The replacement rate measure is time-invariant, which explains the number of observations of 1,204.*

The median $RR_{FP}$ is 0.333, and the median $RR_O$ is 0.485. The mean replacement rates are higher than the median replacement rates. The percentile measures also indicate that both replacement rate-distributions are right skewed.

Table 4.2 provides the number of observations, number of households, mean, standard deviation, first quartile, median, and third quartile of the other variables. The following wealth categories from the HRS together consitute total wealth: Net value of real estate (not primary residence), net value of vehicles, net value of businesses, net value of IRA and Keogh accounts, net value of stocks, mutual funds, and investment trusts, value of checking, savings, or money market accounts, value of CD, government savings bonds, and T-bills, net value of bonds and bond funds, net value of all other savings minus the net value of all other debt, and the value of housing wealth. Housing wealth consists of the value of primary and secondary residence minus the value of all mortgages/land contracts and the value of other home loans for primary and secondary residence. Financial wealth is simply the difference between total wealth and housing wealth. Note that the value of 401(k) accounts is not included in any wealth measure, but is considered as part of the second pillar pension. Furthermore, because we drop all self-employed business equity is irrelevant in our analysis.

All wealth measures are net wealth measures, so the level of debt is subtracted from gross wealth. Median net financial wealth in the sample is around $34,000 (constant 1992 dollars), and median net total wealth is around $100,000.

Table 4.2. *Summary statistics of the sample that we use to estimate the regression models (1992 dollars)*

| Variable | Obs. | Hh's | Mean | St.dev. | Q1 | Median | Q3 |
|---|---|---|---|---|---|---|---|
| Financial Wealth | 10,582 | 1,204 | 133,678 | 320,612 | 4,486 | 33,923 | 134,661 |
| Total Wealth | 9,467 | 1,204 | 215,449 | 389,285 | 27,601 | 100,496 | 252,537 |
| Fin. Wealth/Perm. Inc. | 10,436 | 1,204 | 3.671 | 15.055 | 0.159 | 0.950 | 3.427 |
| Tot. Wealth/Perm. Inc. | 9,342 | 1,204 | 5.928 | 14.806 | 0.929 | 2.929 | 6.578 |
| Age | 10,582 | 1,204 | 63.71 | 6.41 | 59 | 64 | 69 |
| Total Income | 10,582 | 1,204 | 36,531 | 33,642 | 15,816 | 28,416 | 48,000 |
| Permanent Income | 10,436 | 1,204 | 36,858 | 18,639 | 23,514 | 33,338 | 46,002 |
| Couple Household | 10,582 | 1,204 | 0.461 | 0.499 | 0 | 0 | 1 |

Note: *The couple household dummy is time-invariant, as we drop households when one of the members leaves the household (either through divorce or death).*

For both wealth measures the mean is much higher than the median, even after normalizing by permanent income, and the distance between the third quartile and the median is much larger than the distance between the first quartile and the median. This implies that the wealth distribution is right skewed. All household heads in our sample are, by definition, between 51 and 79 years old, although the number of households in the upper part of the age distribution is a bit lower than would be expected. The average and median age of all households is 64 years old. Median total income[4] is around $28,000, and median permanent income is around $33,000. All income measures, before and after retirement, are before-tax.

We determine permanent income by estimating income regressions for four different educational groups, and using the coefficient estimates to predict future household income. We then calculate permanent income as a weighted average of the present values of all past, current, and future incomes, where the discount factors form the weights. A simplification we make is that we set initial wealth (at the age of 20) equal to zero in the calculation. The appendix of chapter 3 contains a detailed description of the construction of permanent income.

Our sample only spans households where the household head is born between 1931 and 1941. Figures 4.1 and 4.2 present cohort-time plots of the median fin-

[4] Total income consists of earnings, income from employer pensions and/or annuities, Social Security income, unemployment compensation, and other government transfers. Capital income is not included in total income.

ancial wealth/permanent income and median total wealth/permanent income ratios. Note that productivity-related cohort effects are not present anymore in these pictures, as wealth is divided by permanent income. $Cohort_{1930}$ consists of households born before 1933, $cohort_{1934}$ of households born in 1933, 1934, 1935, or 1936, $cohort_{1938}$ of households born in 1937, 1938, 1939, or 1940, and $cohort_{1942}$ of households born after 1940. Only households from this last cohort clearly have higher levels of wealth than households from the other three cohorts.

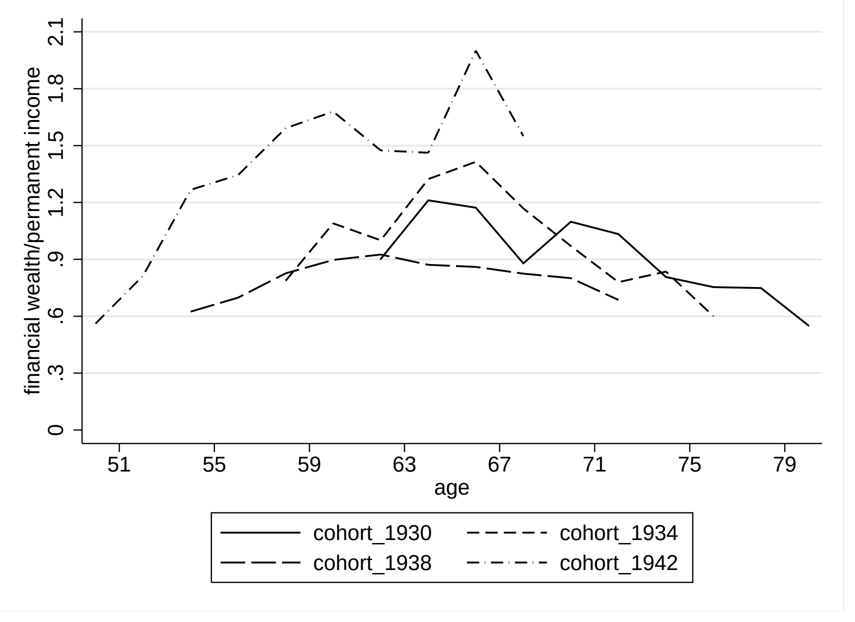


Figure 4.1. Median financial wealth/permanent income across age and cohorts

Less than half of all households in the sample are couple households. This seems to be much lower than for the overall population between 50 and 80 years old. The most obvious explanation is that it is easier to calculate a replacement rate for single households; we just dropped a larger fraction of couple households from the sample, as we were not able to calculate a replacement rate for them (see chapter 3 for details).

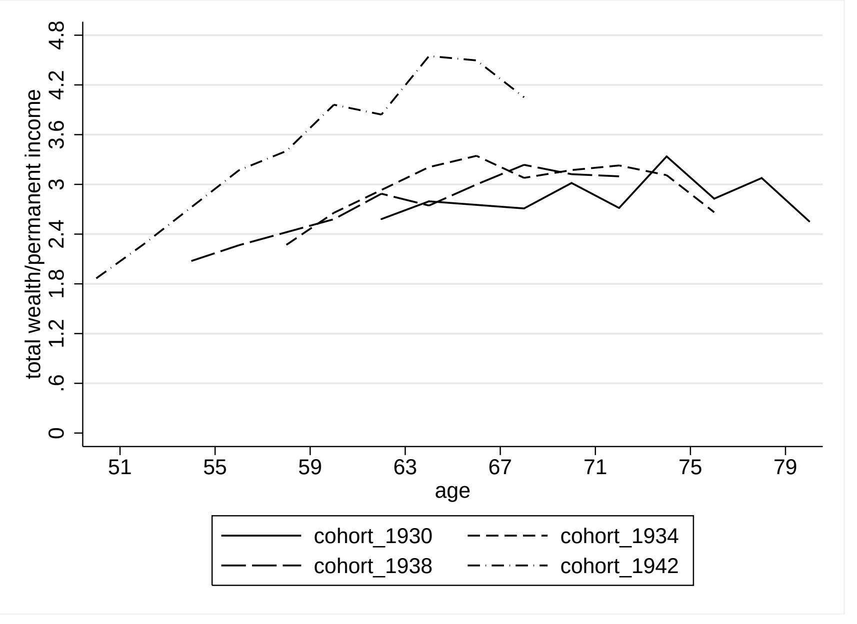


Figure 4.2. Median total wealth/permanent income across age and cohorts

## 4.3 Identification and Empirical Model

Our econometric specification to test the effect of the replacement rate on wealth holdings is as follows:

$$\frac{W_{ht}}{Y_h^P} = \gamma_0 + \gamma_a + \gamma_t + \gamma_1 \log(RR_h) + X'_{ht}\,\beta + \epsilon_{ht}, \tag{4.1}$$

where $W_{ht}$ is net wealth of household $h$ in year $t$, $Y^P$ is permanent income, $\gamma_0$ is a constant, $\gamma_a$ captures the age effect, $\gamma_t$ captures the time effect, $RR_h$ is the replacement rate of household $h$, and $X$ is a vector of control variables, consisting of education dummies, a dummy for couple households, sector dummies, and region dummies. Finally, $\epsilon_{ht}$ is an error term, where we allow for intra-household correlation, so all standard errors that we calculate are clustered at the level of the household.

In a life cycle model with quadratic utility, all productivity-related cohort effects are captured in the dependent variable, through their effect on permanent income (see e.g. Kapteyn et al. (2005)). However, the above specification does not control for other causes of cohort differences in wealth. For example, generations raised during the Great Depression might be thriftier than other generations, and therefore have higher levels of wealth. As the coefficients of a model with age-, time-, and cohort dummies are unidentified, we choose to only include age- and time dummies in the main specification.

There are three sources of endogeneity in equation 4.1. First, unobservable tastes for saving might influence both the replacement rate and the level of wealth. This is an example of omitted variable bias. Second, Coile and Gruber (2007) find that retirement decisions are sensitive to the level of retirement wealth already accrued. Thus, the level of wealth could affect the timing of retirement, which in turn determines the replacement rate. In that case, correlation between the error term and the replacement rate is caused by simultaneity. Finally, pension income as well as earnings are most likely measured with error. The replacement rate is obtained by taking the ratio of these two variables, so the replacement rate will suffer from measurement error.

If thrifty individuals choose jobs based on generous pension arrangements, the effect of the replacement rate on wealth levels would be biased upwards. On the other hand, if wealthy individuals decide to retire earlier, because they can afford so, the effect would be biased downwards. In the displacement literature, measurement error causes a negative correlation between the wealth/permanent income ratio and pension wealth, the main independent variable, because measurement error in pension wealth and permanent income are positively related. In our model, however, the replacement rate is a ratio of two variables that together determine permanent income. We thus believe that the correlation between measurement error in permanent income and measurement error in our main independent variable is not as problematic as in the displacement literature. However, general measurement error in the replacement rate might cause attenuation bias, which would drive the coefficient estimate towards zero.

In order to overcome the endogeneity problem we use an instrument for the replacement rate. We construct this instrument from the data itself. By calculating median replacement rates over census regions and job sectors, we are able to assign a so-called ”potential replacement rate” to each household, which can be used as an instrument for the replacement rate. As long as workers do not sort across employment sectors and do not move to a different census region in search of jobs with more generous pension arrangements, the instrument is exogenous. Note that these assumptions are also made by, among others, Attanasio and Brugiavini (2003) and Engelhardt and Kumar (2011).

The first source of variation in our instrument is thus the census region a household is living. This effect runs through the timing of retirement. Munnell et al. (2008) show that there are considerable differences in labor participation rates of men aged 55-64 across states and census regions. Especially in the regions East South Central and South Atlantic the labor participation rate of older men is low, compared to the rest of the country. In the regions West North Central, and New England, on the other hand, the labor participation rate of this group of men is significantly higher than in the rest of the country. Also, Coile and Gruber (2007) report that early retirement is significantly more prevalent in the Pacific region, and significantly less in New England, compared to the other regions of the country. Early retirement will, ceteris paribus, decrease the replacement rate, as workers simply have had less time to accumulate pension savings. Also, Social Security benefits are lower when they are claimed before the official retirement age. Munnell et al. (2008) show that, after controlling for individual worker characteristics, state- or region-specific labor market conditions are important in determining these differences in labor participation rates of individuals around retirement.

The second source of variation is the sector where the household head has had his or her job with longest reported tenure. We divide the economy in four sectors: the primary sector, the secondary sector, the tertiary sector, and the public sector. The generosity of pension schemes differs widely among sectors. For example, it is well known that pension arrangements in the public sector are generally very good compared to the private sector. Although the replacement rate of Social Security (first pillar) is mainly determined by the level of pre-retirement income (it is decreasing in earnings), the extent to which employer-provided pension plans (second pillar, together with 401(k)) meet the need of a reasonable standard of living after retirement depends, among other things, on the sector in which the worker is employed.

The variation in our instrument will thus be independent of individual characteristics that cause the endogeneity of the replacement rate. Table 4.3 presents median replacement rates for all 9 census regions and 4 employment sectors:

The median $RR_O$ is highest in census region West North Central, which is in line with the evidence of Munnell et al. (2008) that labor participation rates of older men are relatively high in this region. The regions West South Central and Mountain have the lowest median $RR_O$, while New England has the lowest median $RR_{FP}$. This is most probably due to the relatively high income level in New England. As

Table 4.3. *Median values $RR_{FP}$ and $RR_O$ per census region and per sector*

| Census region | Obs. | $RR_{FP}$ | $RR_O$ | Sector | Obs. | $RR_{FP}$ | $RR_O$ |
|---|---|---|---|---|---|---|---|
| New England | 410 | 0.28 | 0.45 | Primary Sector | 336 | 0.40 | 0.46 |
| Mid Atlantic | 1,576 | 0.30 | 0.51 | Secondary Sector | 3,584 | 0.37 | 0.46 |
| East North Central | 1,653 | 0.31 | 0.49 | Tertiary Sector | 5,884 | 0.31 | 0.51 |
| West North Central | 1,058 | 0.37 | 0.55 | Public Sector | 572 | 0.26 | 0.54 |
| South Atlantic | 2,679 | 0.35 | 0.48 | | | | |
| East South Central | 744 | 0.38 | 0.48 | | | | |
| West South Central | 832 | 0.33 | 0.41 | | | | |
| Mountain | 485 | 0.31 | 0.44 | | | | |
| Pacific | 1,120 | 0.30 | 0.51 | | | | |
| $p$-value median test | | 0.000 | 0.000 | | | 0.000 | 0.000 |

expected, the employment sector "Public Sector" has the highest median $RR_O$, and the lowest $RR_{FP}$. The median tests at the bottom of the table show that there are significant differences between sectors and regions for both $RR_{FP}$ and $RR_O$.

To account for the endogeneity of the replacement rate in equation 4.1 we employ the instrumental variable quantile regression (IVQR) estimator of Chernozhukov and Hansen (2008)[5]. The first stage is estimated by OLS, and the second stage by quantile regression. We limit ourselves to the $50^{th}$ percentile, essentially performing median regressions.

An alternative to quantile regression would be to take the log of wealth, as wealth is more or less lognormally distributed. However, around 11% of observations concern non-positive wealth levels, so they would be lost after a logarithmic transformation of the data. It is hard to maintain that this is a random part of the wealth distribution. The sample would become biased towards households with positive wealth holdings. Furthermore, quantile regression is more robust against influential outliers (Koenker, 2005).

## 4.4 Results

We show results in this section. First, we present findings of estimating the baseline model. Second, we split our sample into four groups based on the distribution of the replacement rate, and estimate an age-wealth profile for each of the four groups separately. Finally, we perform robustness checks.

[5] The Matlab file that we use comes from the website of Christian Hansen: http://faculty.chicagobooth.edu/christian.hansen/research/

### 4.4.1 Baseline Specification

Table 4.4 presents results from estimating equation 4.1 by quantile regression (QR) and instrumental variable quantile regression (IVQR). The first two columns contain results for $RR_{FP}$, and the last two columns for $RR_O$. The quantile regression in the first column shows an estimate of -0.160 for the effect of log $RR_{FP}$ on the financial wealth/permanent income ratio. This would imply that a 10% increase in the replacement rate is associated with a fall in the financial wealth/permanent income ratio of about 0.016. The interpretation is that the difference in average lifetime wealth would be \$640 between two households with a permanent income of \$40,000 that are equal to each other in all other respects, except that the household with the higher level of wealth has a 10% lower replacement rate.

Using the IVQR estimator, we find an insignificant estimate of log $RR_{FP}$ of -0.065. Apparently, endogeneity leads to a downward bias of the estimate because taking it into account gives an estimate very close to (and insignificant from) zero. These results suggest that general measurement error can not be the only cause of the endogeneity, because if that would have been the case the QR estimate would have been closer to zero than the IVQR estimate, which is not the case. The coefficient on the instrument in the first stage equals 0.715 and is strongly significant. Furthermore, the partial F-statistic is 12.6. Note that the life cycle model predicts that the age-wealth profile of households with a high replacement rate lies below the profile of households with a low replacement rate. However, it also predicts that the distance between the two profiles is largest around retirement. We will come back to this in the next subsection.

Using $RR_O$ the estimates are -0.120 and -0.052, but the latter estimate is insignificantly different from zero. However, as Engelhardt and Kumar (2011) and Chernozhukov and Hansen (2008) also note, the IVQR estimator is very inefficient. Although the quantile regression estimates are negative and significant, the IVQR estimates are insignificant, so we cannot conclude that there is a negative correlation between the replacement rate and the financial wealth/permanent income ratio. Note also that the partial F-statistic of 6.3 indicates a weak instrument problem. Finally, the education dummies and the couple household dummy have the expected positive signs and are all strongly significant.

Adding housing wealth to financial wealth gives total wealth. It is interesting to examine whether the results for total wealth are comparable to financial wealth as housing wealth is one of the most illiquid forms of wealth. We therefore think that, in the context of the life cycle model, it is appropriate to treat it in a different

Table 4.4. *Quantile Regression (QR) and Instrumental Variable Quantile Regression (IVQR) Estimates*

| *Dependent variable* | Financial Net Wealth/Permanent Income | | | |
|---|---|---|---|---|
| *Estimation method* | **QR** | **IVQR** | **QR** | **IVQR** |
| Log $RR_{FP}$ | -0.160 | -0.065 | | |
| | (0.061)*** | (0.532) | | |
| Log $RR_{O}$ | | | -0.120 | -0.052 |
| | | | (0.066)* | (0.853) |
| Secondary education | 0.425 | 0.422 | 0.423 | 0.410 |
| | (0.082)*** | (0.089)*** | (0.097)*** | (0.426) |
| College education | 0.540 | 0.562 | 0.554 | 0.559 |
| | (0.126)*** | (0.153)*** | (0.101)*** | (0.416) |
| University education | 1.489 | 1.546 | 1.498 | 1.388 |
| | (0.231)*** | (0.340)*** | (0.205)*** | (0.440)*** |
| Couple household | 1.686 | 1.714 | 1.740 | 1.502 |
| | (0.141)*** | (0.167)*** | (0.152)*** | (0.163)*** |
| *First-stage* | | | | |
| Instrument | | 0.715 | | 0.526 |
| | | (0.201)*** | | (0.210)** |
| Partial F-statistic | | 12.6 | | 6.3 |
| Number of observations | 10,049 | 10,049 | 10,168 | 10,168 |
| Number of households | 1,163 | 1,163 | 1,178 | 1,178 |

Notes: *Numbers in parentheses are bootstrapped standard errors, clustered at the household level, based on 100 replications. Standard errors in the first stage are not bootstrapped, but are clustered at the household level as well. *,**,*** denote significance at the 10%, 5% and 1% respectively. All specifications include a full set of age dummies, time dummies, sector dummies, and region dummies. We also estimated the IVQR models without sector and region dummies; the results are comparable to the results we show in this table, although the partial F-statistic becomes more than twice as large.*

manner from other forms of wealth.

The results of the regressions for total wealth are in table 4.5. The IVQR estimate for $RR_{FP}$ is lower than the estimate of the quantile regression, but both are insignificant. The IVQR estimate for $RR_O$ is even positive, but insignificant. So, the evidence concerning an effect of the replacement rate on total wealth is mixed and inconclusive. Note that the number of observations in table 4.5 is a bit lower than in table 4.4. This is because there is no reliable housing wealth measure in the 1996 wave. Therefore, all observations for 1996 are dropped in table 4.5.

Table 4.5. *Quantile Regression (QR) and Instrumental Variable Quantile Regression (IVQR) Estimates*

| *Dependent variable* | Total Net Wealth/Permanent Income | | | |
|---|---|---|---|---|
| *Estimation method* | **QR** | **IVQR** | **QR** | **IVQR** |
| Log $RR_{FP}$ | -0.249 | -0.483 | | |
| | (0.169) | (1.460) | | |
| Log $RR_{O}$ | | | -0.342 | 0.431 |
| | | | (0.195)* | (1.205) |
| Secondary education | 0.916 | 0.877 | 0.965 | 0.991 |
| | (0.185)*** | (0.271)*** | (0.189)*** | (0.498)** |
| College education | 1.094 | 1.055 | 1.175 | 1.242 |
| | (0.238)*** | (0.541)* | (0.232)*** | (0.496)** |
| University education | 2.400 | 2.268 | 2.506 | 2.609 |
| | (0.431)*** | (0.933)** | (0.362)*** | (0.759)*** |
| Couple household | 3.405 | 3.358 | 3.439 | 3.430 |
| | (0.262)*** | (0.323)*** | (0.243)*** | (0.261)*** |
| *First-stage* | | | | |
| Instrument | | 0.715 | | 0.527 |
| | | (0.199)*** | | (0.211)** |
| Partial F-statistic | | 12.9 | | 6.3 |
| Number of observations | 8,996 | 8,996 | 9,101 | 9,101 |
| Number of households | 1,163 | 1,163 | 1,178 | 1,178 |

Notes: *Numbers in parentheses are bootstrapped standard errors, clustered at the household level, based on 100 replications. Standard errors in the first stage are not bootstrapped, but are clustered at the household level as well. *,**,*** denote significance at the 10%, 5% and 1% respectively. All specifications include a full set of age dummies, time dummies, sector dummies, and region dummies. We also estimated the IVQR models without sector and region dummies; the results are comparable to the results we show in this table, although the partial F-statistic becomes more than twice as large.*

### 4.4.2 Age-Wealth Profiles

As already noted, if households behave according to the life cycle model the age-wealth profile of households with a high replacement rate should lie below the profile of households with a low replacement rate. Furthermore, the distance between the profiles should be at its maximum around retirement. Households with a low replacement rate should save more before retirement, and dissave more after retirement, so their age-wealth profile is expected to be steeper than the profile of households with a high replacement rate.

We divide the sample into four subsamples, based on the distribution of the replacement rate. However, due to the endogeneity of the replacement rate, we cannot simply use the data to define the quartiles. Therefore, we first estimate the first stage and base the quartiles on the distribution of the predicted replacement rate, instead of the actual values of the replacement rate. We then estimate quantile regressions for each of the four subsamples, and examine the resulting age-wealth profiles. The estimation procedure consists thus of two steps:

1. OLS regression of the endogenous variable, the (log) replacement rate, on the exogenous variables and the instrument. Based on the regression estimates, we calculate fitted values and define the four quartiles of the predicted replacement rate.

2. Quantile regressions for each of the four samples, with the ratio of wealth to permanent income regressed on the exogenous variables.

Table 4.6 presents the estimation results for financial wealth. The first four columns contain results for $RR_{FP}$, and the last four columns for $RR_O$. Instead of age dummies, we have defined a linear spline in age such that each spline contains an equal amount of observations. As the sample size of each regression is four times as small as in tables 4.4 and 4.5 the model would become overparameterized with age dummies. Furthermore, we have excluded education dummies, region dummies, and sector dummies to limit convergence problems while estimating the model.

The coefficient estimate of the couple household dummy is in line with the findings in tables 4.4 and 4.5. We also show the coefficient estimates for all age spline variables. Figures 4.3 and 4.4 show age-wealth profiles for all four quartiles of the replacement rate distribution, based on these coefficient estimates. The other variables are evaluated at their sample means.

Figure 4.3 reveals that the amount of wealth that is accumulated before retirement is decreasing in $RR_{FP}$. Households from the lowest quartile of the replacement rate-distribution have accumulated six times as much financial wealth, relative to permanent income, around the age of 65 than households in the highest quartile of the distribution. This is in line with the predictions of the life cycle model. The picture of wealth decumulation after retirement is less clear, which is partly caused by the large standard errors of the estimates of age 70-79. However, it seems that households in the highest two quartiles of the distribution, so with the highest $RR_{FP}$'s, do not dissave after retirement. This is again what the life cycle model predicts.

Households with a lower $RR_{FP}$ keep saving after retirement. Possible explanations might be uncertain life expectancies and the risk of out-of-pocket medical expenses for these households (see De Nardi et al. (2009, 2010)). In addition, sev-

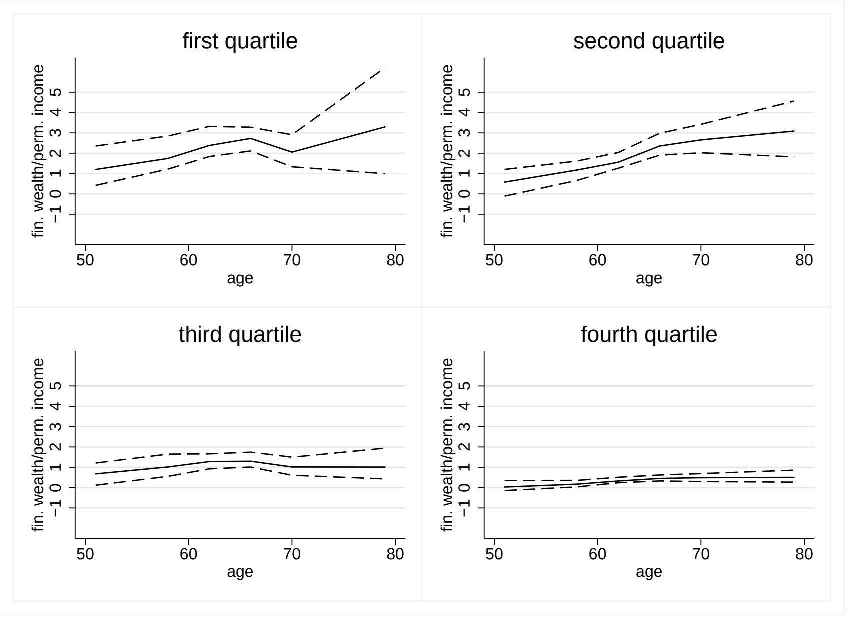


Figure 4.3. Age-financial wealth profiles (solid lines) for all quartiles of the $RR_{FP}$-distribution. The dashed lines represent 95% confidence bounds, based on 1000 bootstrap replications (clustered at the household level).

eral studies have documented that households experience a drop in consumption around retirement (e.g., Banks et al. (1998), Bernheim et al. (2001), Haider and Stephens (2007)). This could also explain why households do not dissave after retirement, namely that they simply do not need to as their pension income is high enough to satisfy their consumption needs.

The age-wealth profiles in figure 4.4, where the quartiles of the $RR_O$-distribution are used, are comparable to the ones in figure 4.3. Again, in none of the four groups households decumulate wealth after retirement, while the accumulation of wealth before retirement is decreasing in the replacement rate.

If we include housing wealth the picture roughly stays the same, as table 4.7 and figures 4.5 and 4.6 reveal. If there is any wealth decumulation at all, it is in the lowest quartiles of the replacement rate distribution. Furthermore, also total wealth is decreasing in the replacement rate.

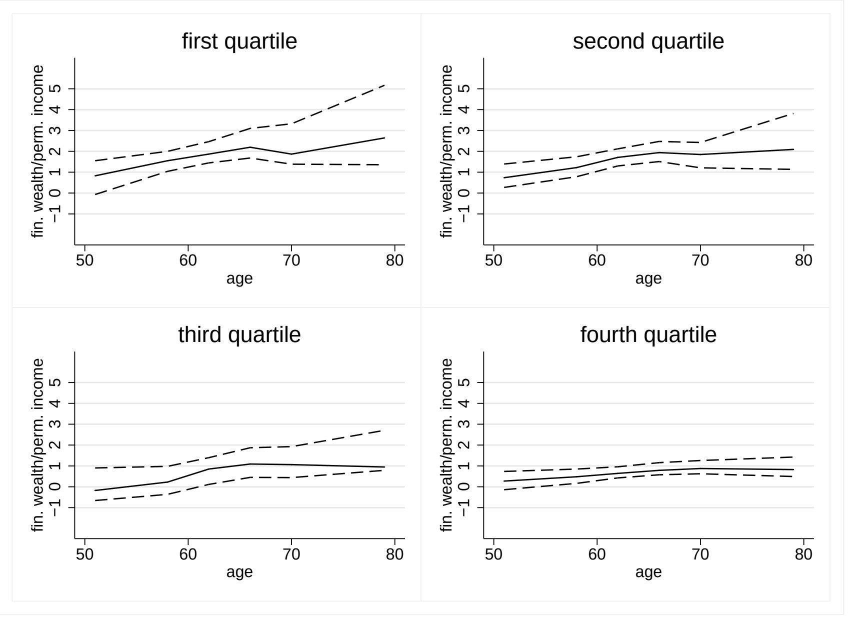


Figure 4.4. Age-financial wealth profiles (solid lines) for all quartiles of the $RR_O$-distribution. The dashed lines represent 95% confidence bounds, based on 1000 bootstrap replications (clustered at the household level).

### 4.4.3 Robustness Checks

To check the influence of accounting for the endogeneity of the replacement rate on our findings, we perform a robustness check. Instead of dividing the sample in four parts based on the distribution of the fitted values of a regression with the replacement rate as left-hand side variable, we divide the sample in four parts based on the actual distribution of the replacement rate. We thus treat the replacement rate as an exogenous variable. Tables 4.8 and 4.9 present the regression results for the four groups, and figures 4.7-4.10 show the age-wealth profiles that these regression results imply.

The main difference with the baseline results is that when we divide the sample on the basis of actual replacement rates, households in the lowest two quartiles of the $RR_{FP}$ distribution decumulate wealth after retirement, while these groups keep accumulating wealth in the baseline model. Of course, the nature of the robustness check implies that the composition of these groups differs. However, in general we observe the same patterns as in figures 4.3-4.6: Wealth accumulation is decreasing in the replacement rate and there is hardly decumulation of wealth after retirement.

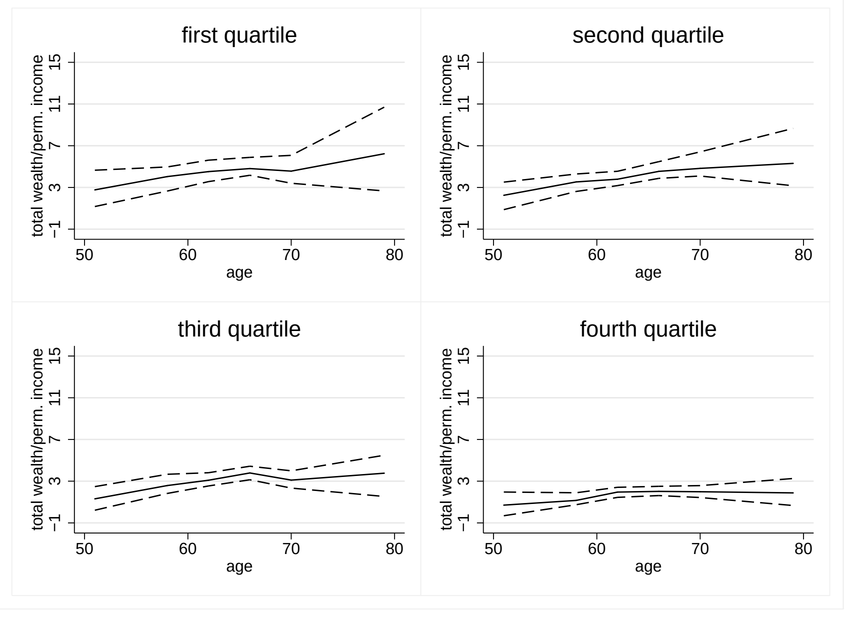


Figure 4.5. Age-total wealth profiles (solid lines) for all quartiles of the $RR_{FP}$-distribution. The dashed lines represent 95% confidence bounds, based on 1000 bootstrap replications (clustered at the household level).

Table 4.6. *Quantile Regressions with Subsamples Based on the Replacement Rate-Distribution*

| *Dependent variable* | Financial Net Wealth/Permanent Income | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Replacement rate | $RR_{FP}$ | | | | $RR_O$ | | | |
| Quartile replacement rate-distr. | 1st | 2nd | 3rd | 4th | 1st | 2nd | 3rd | 4th |
| Age 51-58 | 0.078 | 0.085 | 0.048 | 0.020 | 0.103 | 0.069 | 0.042 | 0.030 |
| | (0.038)** | (0.038)** | (0.029)* | (0.011)* | (0.044)** | (0.028)** | (0.030) | (0.018) |
| Age 58-62 | 0.159 | 0.096 | 0.066 | 0.039 | 0.080 | 0.123 | 0.119 | 0.041 |
| | (0.068)** | (0.067) | (0.059) | (0.021)* | (0.068) | (0.048)** | (0.048)** | (0.027) |
| Age 62-66 | 0.087 | 0.199 | 0.004 | 0.032 | 0.082 | 0.057 | 0.084 | 0.036 |
| | (0.085) | (0.064)*** | (0.044) | (0.018)* | (0.075) | (0.056) | (0.050)* | (0.030) |
| Age 66-70 | -0.168 | 0.075 | -0.070 | 0.009 | 0.019 | -0.023 | -0.002 | 0.022 |
| | (0.081)** | (0.055) | (0.043)* | (0.015) | (0.067) | (0.046) | (0.043) | (0.022) |
| Age 70-79 | 0.138 | 0.048 | -0.001 | 0.002 | 0.086 | 0.027 | 0.039 | -0.006 |
| | (0.098) | (0.056) | (0.026) | (0.012) | (0.070) | (0.046) | (0.042) | (0.016) |
| Couple household | 2.447 | 2.110 | 1.469 | 0.773 | 2.156 | 2.101 | 1.740 | 1.513 |
| | (0.358)*** | (0.223)*** | (0.264)*** | (0.182)*** | (0.243)*** | (0.341)*** | (0.262)*** | (0.370)*** |
| Number of observations | 2,556 | 2,561 | 2,569 | 2,524 | 2,558 | 2,556 | 2,553 | 2,543 |
| Number of households | 321 | 359 | 368 | 326 | 371 | 426 | 416 | 362 |

Notes: *Numbers in parentheses are bootstrapped standard errors, clustered at the household level, based on 100 replications. *,**,*** denote significance at the 10%, 5% and 1% respectively. In the first step the endogenous variables, (log) $RR_{FP}$ and (log) $RR_O$ are regressed on the exogenous variables and the instrument. Based on the regression estimates, we calculate fitted values and define the four quartiles of the predicted $RR_{FP}$ and $RR_O$. In the second step we perform quantile regressions for each of the four subsamples, with the ratio of wealth to permanent income regressed on the exogenous variables. All specifications include a full set of time dummies. The age effects are captured by a linear spline in age. Education dummies, region dummies, and sector dummies are excluded in the quantile regressions to limit convergence problems, but note that these dummies are included to determine the distribution of the replacement rate in the first step. We also estimated all specifications with a dummy for $cohort_{1942}$ included (see section 2). However, the coefficient estimate is insignificant in all specifications and the estimates of the other coefficients are comparable to the ones in this table.*

Table 4.7. *Quantile Regressions with Subsamples Based on the Replacement Rate-Distribution*

| *Dependent variable* | Total Net Wealth/Permanent Income | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Replacement rate | $RR_{FP}$ | | | | $RR_O$ | | | |
| Quartile replacement rate-distr. | 1st | 2nd | 3rd | 4th | 1st | 2nd | 3rd | 4th |
| Age 51-58 | 0.152 | 0.198 | 0.202 | 0.081 | 0.241 | 0.181 | 0.051 | 0.151 |
| | (0.080)** | (0.063)*** | (0.050)*** | (0.064) | (0.053)*** | (0.067)*** | (0.084) | (0.039)*** |
| Age 58-62 | 0.157 | 0.052 | 0.127 | 0.200 | 0.138 | 0.098 | 0.098 | 0.204 |
| | (0.113) | (0.089) | (0.090) | (0.054)*** | (0.136) | (0.100) | (0.079) | (0.076)*** |
| Age 62-66 | 0.069 | 0.196 | 0.179 | 0.013 | 0.161 | 0.203 | 0.108 | 0.133 |
| | (0.120) | (0.119)* | (0.109) | (0.048) | (0.153) | (0.124) | (0.089) | (0.070)* |
| Age 66-70 | -0.065 | 0.071 | -0.171 | -0.004 | 0.087 | -0.186 | -0.028 | 0.071 |
| | (0.167) | (0.107) | (0.107) | (0.078) | (0.145) | (0.109)* | (0.105) | (0.075) |
| Age 70-79 | 0.186 | 0.054 | 0.073 | -0.013 | 0.038 | 0.045 | -0.012 | 0.120 |
| | (0.190) | (0.117) | (0.072) | (0.062) | (0.148) | (0.139) | (0.078) | (0.086) |
| Couple household | 3.832 | 3.657 | 2.919 | 3.144 | 3.674 | 3.684 | 3.141 | 3.585 |
| | (0.558)*** | (0.420)*** | (0.341)*** | (0.459)*** | (0.447)*** | (0.465)*** | (0.364)*** | (0.489)*** |
| Number of observations | 2,278 | 2,295 | 2,294 | 2,271 | 2,296 | 2,290 | 2,279 | 2,273 |
| Number of households | 328 | 359 | 368 | 326 | 371 | 424 | 415 | 358 |

Notes: *See table 4.6*

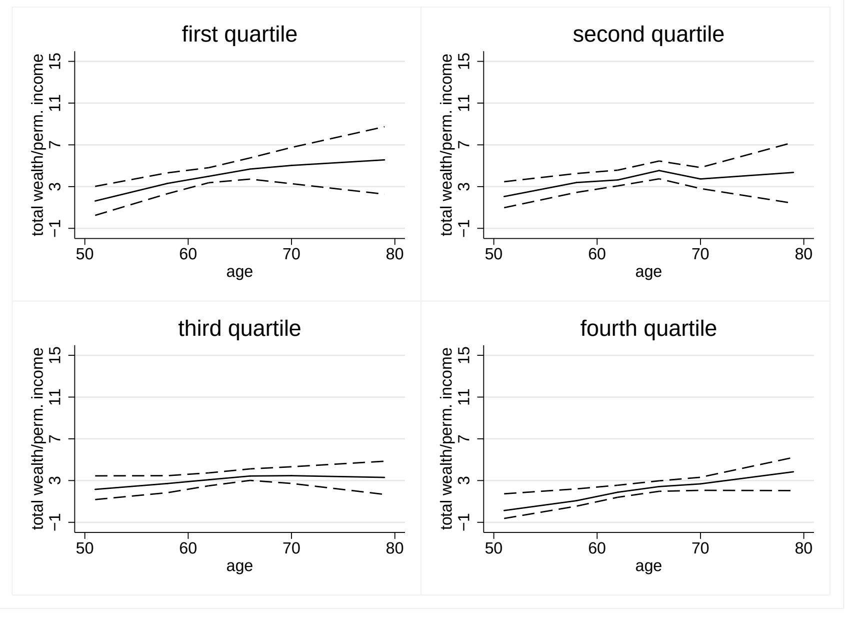


Figure 4.6. Age-total wealth profiles (solid lines) for all quartiles of the $RR_O$-distribution. The dashed lines represent 95% confidence bounds, based on 1000 bootstrap replications (clustered at the household level).

Table 4.8. *Quantile Regressions with Subsamples Based on the Replacement Rate-Distribution*

| *Dependent variable* | Financial Net Wealth/Permanent Income | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Replacement rate | $RR_{FP}$ | | | | $RR_O$ | | | |
| Quartile replacement rate-distr. | 1st | 2nd | 3rd | 4th | 1st | 2nd | 3rd | 4th |
| Age 51-58 | 0.068 | 0.079 | 0.032 | 0.006 | 0.067 | 0.029 | 0.026 | 0.035 |
| | (0.038)* | (0.028)*** | (0.028) | (0.016) | (0.034)** | (0.026) | (0.024) | (0.026) |
| Age 58-62 | 0.102 | 0.049 | 0.018 | 0.055 | 0.121 | 0.103 | 0.049 | 0.024 |
| | (0.057)* | (0.050) | (0.044) | (0.024)** | (0.058)** | (0.043)** | (0.049) | (0.031) |
| Age 62-66 | -0.097 | 0.132 | -0.003 | 0.060 | 0.056 | -0.039 | 0.071 | 0.088 |
| | (0.085) | (0.066)** | (0.045) | (0.030)** | (0.068) | (0.040) | (0.054) | (0.039)** |
| Age 66-70 | -0.078 | -0.053 | -0.067 | 0.004 | -0.015 | -0.030 | -0.080 | 0.010 |
| | (0.077) | (0.057) | (0.044) | (0.016) | (0.060) | (0.039) | (0.040)** | (0.033) |
| Age 70-79 | -0.078 | -0.020 | -0.002 | 0.029 | 0.083 | -0.011 | -0.030 | 0.057 |
| | (0.051) | (0.047) | (0.035) | (0.021) | (0.058) | (0.032) | (0.023) | (0.030)* |
| Couple household | 2.602 | 2.423 | 1.092 | 0.892 | 3.263 | 1.792 | 1.832 | 1.323 |
| | (0.345)*** | (0.312)*** | (0.225)*** | (0.242)*** | (0.425)*** | (0.250)*** | (0.282)*** | (0.267)*** |
| Number of observations | 2,580 | 2,569 | 2,575 | 2,551 | 2,596 | 2,292 | 2,275 | 2,274 |
| Number of households | 299 | 290 | 293 | 299 | 303 | 298 | 298 | 297 |

Notes: *Numbers in parentheses are bootstrapped standard errors, clustered at the household level, based on 100 replications. *,**,*** denote significance at the 10%, 5% and 1% respectively. We divide the sample into four quartiles, based on the distribution of $RR_{FP}$ and $RR_O$. We perform quantile regressions for each of the subsamples, with the ratio of wealth to permanent income regressed on the exogenous variables. All specifications include a full set of time dummies. The age effects are captured by a linear spline in age. Education dummies, region dummies, and sector dummies are excluded in the quantile regressions to limit convergence problems. Note that possible endogeneity of the replacement rate is fully ignored in these regressions. We also estimated all specifications with a dummy for $cohort_{1942}$ included (see section 2). However, the coefficient estimate is insignificant in all specifications and the estimates of the other coefficients are comparable to the ones in this table.*

Table 4.9. *Quantile Regressions with Subsamples Based on the Replacement Rate-Distribution*

| *Dependent variable* | Total Net Wealth/Permanent Income | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Replacement rate | $RR_{FP}$ | | | | $RR_O$ | | | |
| Quartile replacement rate-distr. | 1st | 2nd | 3rd | 4th | 1st | 2nd | 3rd | 4th |
| Age 51-58 | 0.044 | 0.225 | 0.047 | 0.129 | 0.187 | 0.153 | 0.099 | 0.126 |
| | (0.079) | (0.056)*** | (0.055) | (0.048)*** | (0.060)*** | (0.055)*** | (0.069) | (0.044)*** |
| Age 58-62 | 0.110 | 0.011 | 0.069 | 0.155 | 0.091 | 0.184 | 0.048 | 0.102 |
| | (0.097) | (0.092) | (0.067) | (0.069)** | (0.106) | (0.082)** | (0.084) | (0.074) |
| Age 62-66 | -0.075 | 0.113 | 0.068 | 0.148 | 0.034 | 0.020 | 0.091 | 0.170 |
| | (0.121) | (0.108) | (0.089) | (0.099) | (0.124) | (0.083) | (0.084) | (0.095)* |
| Age 66-70 | -0.211 | -0.107 | -0.120 | 0.016 | -0.001 | 0.025 | -0.104 | -0.042 |
| | (0.131) | (0.085) | (0.076) | (0.080) | (0.133) | (0.113) | (0.074) | (0.093) |
| Age 70-79 | -0.175 | -0.059 | 0.049 | 0.164 | -0.047 | 0.044 | -0.147 | 0.148 |
| | (0.071)** | (0.113) | (0.085) | (0.071)** | (0.141) | (0.099) | (0.061)** | (0.060)** |
| Couple household | 4.261 | 3.392 | 2.680 | 3.088 | 5.004 | 4.001 | 3.084 | 2.712 |
| | (0.582)*** | (0.405)*** | (0.371)*** | (0.359)*** | (0.682)*** | (0.438)*** | (0.423)*** | (0.353)*** |
| Number of observations | 2,310 | 2,299 | 2,302 | 2,289 | 2,330 | 2,323 | 2,330 | 2,322 |
| Number of households | 299 | 290 | 293 | 299 | 303 | 298 | 298 | 297 |

Notes: *See table 4.8*

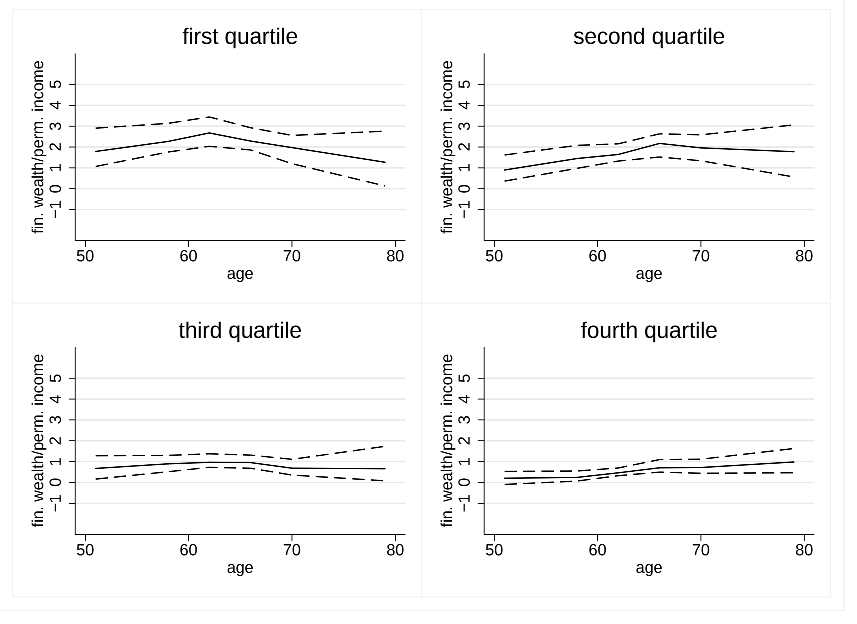


Figure 4.7. Age-financial wealth profiles (solid lines) for all quartiles of the $RR_{FP}$-distribution. Note that possible endogeneity is ignored in determining this distribution. The dashed lines represent 95% confidence bounds, based on 1000 bootstrap replications (clustered at the household level).

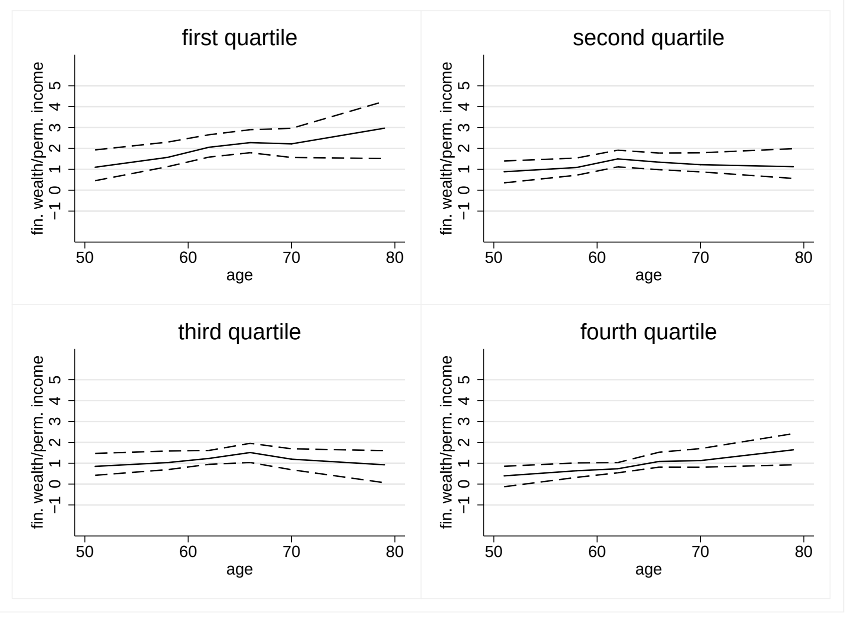


Figure 4.8. Age-financial wealth profiles (solid lines) for all quartiles of the $RR_O$-distribution. Note that possible endogeneity is ignored in determining this distribution. The dashed lines represent 95% confidence bounds, based on 1000 bootstrap replications (clustered at the household level).

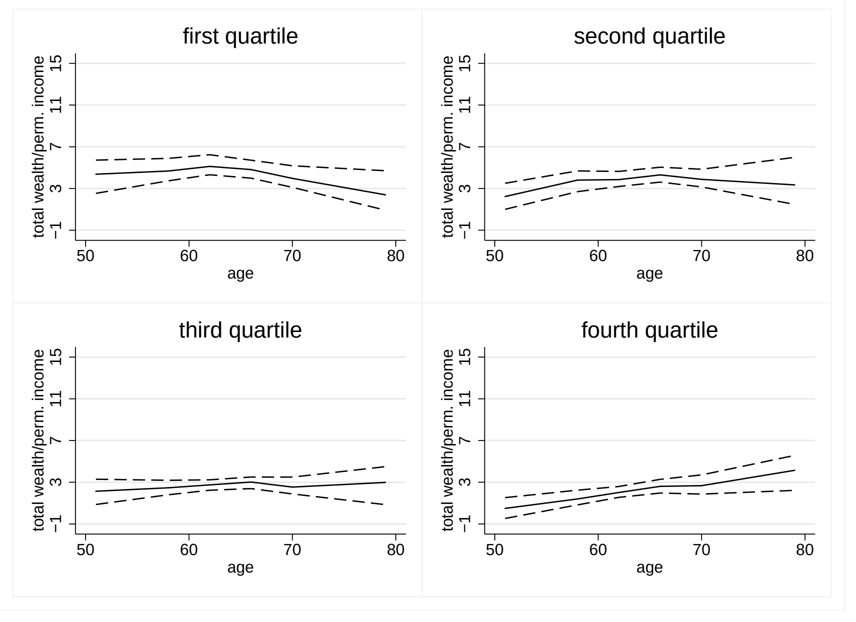


Figure 4.9. Age-total wealth profiles (solid lines) for all quartiles of the $RR_{FP}$-distribution. Note that possible endogeneity is ignored in determining this distribution. The dashed lines represent 95% confidence bounds, based on 1000 bootstrap replications (clustered at the household level).

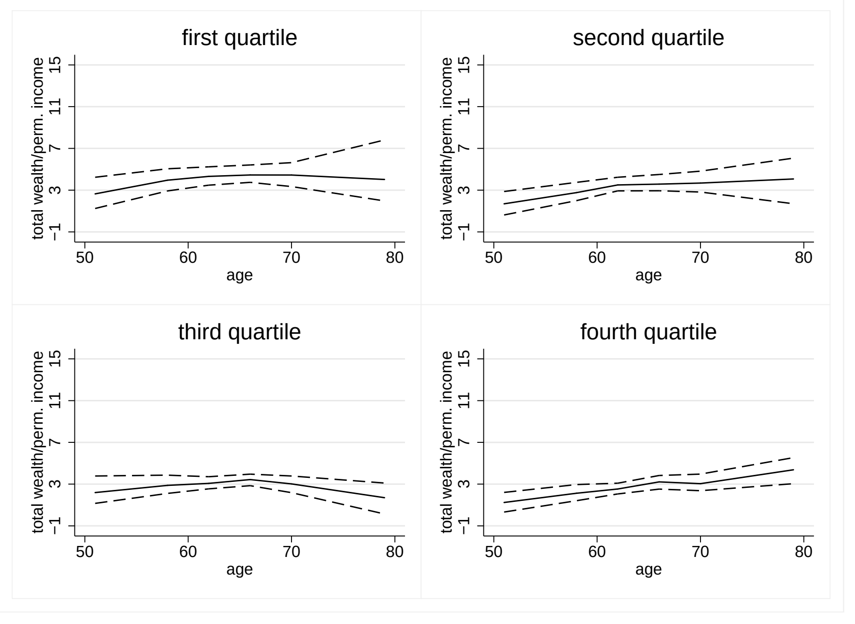


Figure 4.10. Age-total wealth profiles (solid lines) for all quartiles of the $RR_O$-distribution. Note that possible endogeneity is ignored in determining this distribution. The dashed lines represent 95% confidence bounds, based on 1000 bootstrap replications (clustered at the household level).

## 4.5 Conclusions

The finding that large groups of households keep saving after retirement is already well-documented in the literature (see, among others, Alessie et al. (1997), Banks and Rohwedder (2003)). We confirm this finding. However, we do not find support for the hypothesis that the amount of financial wealth is decreasing in the retirement replacement rate. So, we are unable to claim a causal effect of the replacement rate on the amount of accumulated wealth. Whether this effect is simply not there or the IVQR estimator is too inefficient remains an open question. Finally, the age-wealth profile of households in the highest quartile of the replacement rate-distribution is very flat, which is in line with the predictions of the life cycle model.

One of the limitations of our study is that we do not have access to information about the state where households are living. Using this information would make the instrument stronger, as the variation in replacement rates is much larger between states than between census regions. Furthermore, data on the complete income history of households would allow us to improve the caluculation of permanent income and the replacement rate. An interesting avenue for future research would be to examine what the main determinants are of differences in replacement rates. Also, the issues around the calculation of replacement rates deserve some more attention.

*Chapter 5*

# Funding of pensions and economic growth: Are they really related?

## 5.1 Introduction

In many countries pay-as-you-go (PAYG) pension systems are being replaced by (partly) funded pension systems, a shift largely motivated by population aging. Proponents of these shifts also argue that funded pension systems can lead to higher economic growth. If this effect arises during the transition, it could partly alleviate the transition burden associated with the shift from PAYG to funding (Borsch-Supan et al., 2005). Considering the vast number of countries undertaking similar transitions, it is useful to examine whether these shifts led to higher economic growth rates.

A few empirical studies (Holzmann, 1997a,b, Davis and Hu, 2008) argue that funding of pensions is associated with higher economic growth rates, due to higher saving rates, capital market development and reduced labor market distortions. In a PAYG system, pension contributions represent transfers from the young to the old; in a funded pension system, the contributions can be viewed as savings. Therefore, a higher degree of funding means more people save through their mandatory pension scheme, which should lead to a higher aggregate saving rate. Capital market development also could be stimulated because more resources become available

This chapter is based on Zandberg and Spierdijk (2013) for the capital market when pensions are funded. Finally, labor market distortions might be mitigated, because funded pension systems have less distorting effects on labor supply decisions than do unfunded systems. These three effects all suggest higher growth.

Our evidence of an effect of funding on growth is mixed. For the short-run we do not find any effect at all, while we find some evidence for an effect in the long-run. However, this latter evidence highly depends on the empirical model that we use. There seems to be a positive effect when we estimate a model with overlapping observations, but we do not find this positive effect when we use a simple cross-sectional model.

The data set we use spans 54 countries, 29 of which are OECD countries, during the years 2001-2010. To examine whether changes in the degree of funding affect economic growth in the short-run we estimate a dynamic growth model with the growth rate of the ratio of pension assets over GDP as main explanatory variable. We employ a bias-corrected Least Square Dummy Variable (LSDV)-estimator with bootstrap standard errors where we assume country-specific steady-state growth rates. The growth rate of pension assets is insignificant in all specifications, with coefficient estimates that are very close to zero. We also estimate a model without country fixed effects, and the results are comparable.

To find a possible long-run effect we use a simple cross-sectional growth model and estimate it by OLS. Once we also include initial income, which has a negative effect on growth as predicted by the convergence literature (see Barro (1997)), the growth rate of pension assets becomes insignificant. However, when we estimate a growth model with overlapping observations the growth rate of pension assets has a significantly positive effect on economic growth, which remains after the inclusion of initial income, although the coefficient estimates become smaller. We correct the standard errors in the overlapping observations model for serial correlation that is caused by the overlapping nature of the data.

Davis and Hu (2008) also examine empirically whether the level of pension assets, scaled by GDP, is related to economic growth; they conclude that pension fund growth is positively related to economic growth, especially in emerging market economies. Holzmann (1997a,b) finds a positive relationship between pension reform and total factor productivity in Chile, and Davis (2002, 2004) has examined the link between institutionalization (i.e., the proportion of equity held by institutional investors) and GDP growth but finds no effect. However, these last two studies do not test the hypothesis that pension funding increases economic growth, because they include insurance companies and mutual funds as part of institutional investors.

The rest of the chapter is organized as follows: In Section 2 we present the theory. Then in Section 3, we describe the data, followed in Section 4 by a description of the empirical strategy and the results. Finally, we conclude in Section 5.

## 5.2 Theory

In this section we consider the channels through which funding might influence economic growth. We divide these into the effect through the aggregate saving rate, which has received most attention in the literature, and other channels.

Pension systems can be funded, unfunded, or partly funded. In an unfunded pension system, or PAYG system, the currently young pay taxes that are used to pay pensions to the currently old in the same period. In a funded pension system, young workers contribute to a pension fund and then receive pension benefits from this fund when they retire. In a PAYG system, no pension assets exist, because the contributions are immediately used to pay pension benefits; a funded system instead has a pool of assets available. In most countries, pension systems combine PAYG and funded elements, though worldwide trends indicate increased switching from PAYG to (partly) funded pension systems. This switch creates considerable transition costs, because the windfall gain for the first generation of pension beneficiaries must be paid back implicitly (Sinn, 2000). Borsch-Supan et al. (2005) argue however that such pension reforms lead to higher economic growth, because they increase saving rates and the efficiency of capital markets, which partly compensates for the transition costs. Furthermore, increased growth should alleviate problems associated with an aging population, which are the primary motives for reforming pension systems. These arguments suggest that funding of pensions can increase economic growth rates by increasing the aggregate saving rate, development of capital markets, reducing labor market distortions, and improving corporate governance.

### 5.2.1 Aggregate Saving Rate

The contributions of workers to a PAYG system represent a pure tax, because they are used immediately to pay pension benefits to retirees. In contrast, the pension premiums in a funded system constitute savings that get invested in the capital market. A shift toward more funding therefore might increase the aggregate saving rate and, accordingly, may increase economic growth. For this effect to be operative in practice, three conditions must be fulfilled (Barr, 2000): Funding must lead to a higher saving rate than PAYG, the additional savings must induce more investment, and additional investments must lead to a higher economic growth rate.

Although the effect of funding on saving could be permanent, it might be highest during the transition from the PAYG system to the funded system. That is, during the transition, funds build-up and this leads to a net increase in pension fund assets. At some point in time though, the pension fund matures, and the net inflow of funds slows or even becomes negative, such that the outflow of funds to pension beneficiaries creates dissaving.

A few other issues may play a role as well. The transition to a funded system must be financed by either the government or the workers. In the former case, the government issues debt that might undo the possible positive effect on the aggregate saving rate. Furthermore, as Blanchard and Fischer (1989) point out, a funded pension system can increase the aggregate saving rate only if the pension fund forces people to save more than they would have saved voluntarily. If saving rates are already high, people simply replace part of their voluntary saving with the mandatory pension saving, and the aggregate saving rate might stay the same.

Davis and Hu (2006) argue that financial liberalization affects the relationship between funding and saving. That is, households living in countries with a relatively repressed financial sector might face liquidity constraints, so in these countries forced saving should have a greater effect on the national saving rate than it does in countries with a more liberalized financial system. However, there liquidity constraints could play a role among low-income households.

The question of whether funding leads to more saving has been examined extensively in the empirical literature. The comprehensive international study of Reisen and Bailliu (1997) considers the link between pension fund assets and saving rates, using data from 11 OECD- and non-OECD countries. They conclude that the accumulation of pension fund assets has a positive and significant impact on private saving, though the effect is eight times greater for non-OECD countries than for OECD countries. Lopez-Murphy and Musalem (2004) test whether the accumulation of pension fund assets influences national saving rates; they find that it increases national saving when the funds are part of a mandatory pension program but decreases it if the pension funds represent public programs to foster voluntary pension saving. Bosworth and Burtless (2004) also provide evidence that pension saving substitutes for other forms of private saving in OECD countries.

According to Samwick (2000), the effect of funding on saving depends primarily on the way the government chooses to finance the transition. There is a cohort that has paid pension premiums into a PAYG system, but will not be able to collect benefits from it. That is, the cohort immediately after them pays its pension premiums into the new funded system (i.e., their contributions are invested in the capital market, instead of being paid immediately as pension benefits). The government must finance this 'gap', which often entails higher taxes or government debt. Samwick (2000) undertakes an empirical analysis: First, he analyzes the time-series behavior of several countries that have undergone a pension reform and finds that none of them, with the exception of Chile, experienced a significant increase in national saving after the reform. Second, he assesses saving rates in a cross-sectional data set and finds that countries with PAYG systems tend to have lower saving rates than those with funded pension systems. Thus evidence on the link between funding and saving is mixed.

Moreover, a priori it is not clear whether higher saving automatically translates into more investment. On the one hand, a lot of pension funds invest members' contributions in a portfolio of worldwide securities. For example, in 2003 Dutch pension funds invested 57% of their funds abroad (Kakes, 2006). Thus a higher saving rate could have only limited influence on domestic investment. On the other hand, in some countries the government forces pension funds to invest a large part of their funds in their own country. Furthermore, the 'Feldstein-Horioka puzzle'[2] (Feldstein and Horioka, 1980) indicates that domestic investment is strongly related to domestic saving (Davis and Hu, 2008). It also depends on the quality of investment. An example from the latter days of communism shows extremely high investment rates in the Soviet Union, with economic growth rates close to nil (Barr, 2000). Finally, when pension funds use funds to finance government debt, it is questionable whether productive investments result.

It is important to stress that the saving channel reflects a possible long-term effect. It simply takes a few years before higher saving might translate into higher economic growth.

[2] The 'Feldstein-Horioka puzzle' notes that though capital can flow freely across the world in search of the highest possible return, saving and investment within a single country remain strongly related.

### 5.2.2 Other Channels

The development of capital markets also might allow funding to influence economic growth. The literature has established a clear positive link between funding and financial development (Catalan et al., 2000, Impavido et al., 2003, Hu, 2005), and financial development is positively associated with economic growth (Levine and Zervos, 1998, Beck and Levine, 2004). Thus it appears that funding leads to better developed capital markets, which enhance growth in turn. Yet Barr and Diamond (2006) argue that capital market development is a less relevant argument for developed economies, whose capital markets are already quite well-developed. On the other hand, in developing countries with capital markets that are hardly developed yet, this could affect economic growth in the short-run already.

A shift from a PAYG system to a funded pension system decreases the amount of distorting taxes that the government has to collect (Disney et al., 2004). Also, the weak link between pension contributions and benefits in PAYG systems leads workers to retire earlier and engage in less job mobility (Disney, 2002). Therefore, a shift from PAYG to funding might increase economic efficiency and lead to higher growth. However, simulation studies show that the effects are actually rather small (Raffelhuschen, 1993, Kotlikoff, 1996).

Finally, another argument put forward in the literature indicates that funding of pensions could increase growth by improving corporate governance (Barr and Diamond, 2006, Davis and Hu, 2008), perhaps due to pension funds' demand for more transparency and accountability at the firm level, as well as pressures on pension funds to undertake socially responsible investments (Clark and Hebb, 2003). Despite clear evidence of such a positive impact at the firm level in the United States (Woidtke, 2002, Coronado et al., 2003), only Davis (2002) argues that these effects may be economy-wide.

## 5.3 Data Description

To examine the possible effect of changes in the degree of pension funding on economic growth, we use data on the amount of pension assets at the country-level. These data come from the OECD Statistics and consist of the total amount of pension assets for 54 countries during the period 2001-2010. Of these, 29 are OECD countries and 25 are non-OECD countries. For 25 countries, we have data for all the years; for 29 countries the time series is incomplete. We thus have 416 observations pertaining to the amount of pension assets.

Contrary to earlier studies, we use the amount of pension assets instead of the amount of pension fund assets as a measure of funding. This total amount of pension assets is a broader measure than only the assets of pension funds. The difference between total pension assets and the assets of pension funds consists of pension insurance contracts, book reserves on balance sheets of sponsoring companies, banks' managed funds, investment companies' managed funds and all kinds of other funds. For most countries, these represent just a small part of total pension assets; however, in the United States, Denmark, Sweden, France, and South Korea they make up around or even more than 50% of total pension assets. In our view, whether pension savings are invested by pension funds or by some other institute does not make a difference in the context of our study.

Davis and Hu (2008) use the ratio of pension fund assets over GDP as a proxy for pension funding, because changes in the amount of pension assets over time can result from changes in the degree of funding. We believe that it may be necessary to correct the amount of pension assets for the rate of return that the pension sector earns. Increases in the amount of pension assets that result from capital market gains do not reflect changes in the degree of funding. On the other hand, there might be feedback effects as well; an increase in the degree of funding could have a positive impact on the rate of return. We will therefore estimate the empirical model that we describe in the next section with and without the rate of return of the pension sector included as control variable.

The GDP data come from the Penn World Tables 7.0. Furthermore, to calculate the rates of return on pension assets, we use several data sources. The OECD Statistics provide (incomplete) data about the shares of investment portfolios that pension funds allocate to stocks, bonds, loans, cash, and so on. The MSCI World Gross Return Index, which includes reinvested gross dividends, provides a measure of rates of return on stocks. Furthermore, we take returns on the Barclays Capital Global Aggregate Bond Index as a measure for bond returns. Finally, we use the interest rate on three-month Treasury bills as a measure of the return that pension funds earn on their cash.

The following equation shows how we calculate the rate of return of the pension sector for country $i$ in year $t$:

$$r_{it} = \frac{(\text{MSCI}_t * \omega_{it} + \text{Bond Return}_t * \alpha_{it} + T\text{-bill}_t * \pi_{it})}{(\omega_{it} + \alpha_{it} + \pi_{it})}.$$

$\omega$, $\alpha$ and $\pi$ are the shares of the investment portfolio that are allocated to stocks, bonds (which we define to include loans), and cash, respectively.

We make three assumptions in this calculation. First, all pension funds (or other institutes that invest money for future retirees) invest in a worldwide portfolio of securities. Second, real estate earns the same rate of return as stocks and all other investments (land, unallocated insurance contracts, private investment funds and other investments) earn the average rate of return for stocks, bonds and cash combined. Therefore, $\omega$, $\alpha$, and $\pi$ do not necessarily sum to one. Third, because we do not have data about the shares of the different investment categories for all country-year observations, for countries for which we lack some data, we take the average of the available years and use it to represent the shares for the missing years. For countries with no data at all, we take the average over all available countries in that year.

In table 5.1 we provide descriptive statistics of our data. For each variable, the table displays the number of observations, mean, standard deviation, minimum and maximum. Besides that, we show the between- and within-country standard deviations and the number of countries ($n$) and time periods ($T$). Note that the amount of pension assets as a fraction of GDP varies between 0% and about 178%; that is, our sample includes countries with completely PAYG and countries with nearly fully funded pension systems. Besides the level, we show the growth rate of pension assets/GDP. The maximum growth rate is over 400%, which is caused by the fact that there are some countries with hardly any pension assets at all. A tiny increase then immediately results in a very high growth rate.

Table 5.1. *Summary statistics*

| Variable | | Numb. of Obs. | Mean | Std. Dev. | Min. | Max. |
|---|---|---|---|---|---|---|
| Real GDP per capita growth | Overall | N=484 | 2.35 | 3.73 | -19.29 | 12.09 |
| | Between | n=54 | | 1.56 | | |
| | Within | T=8-9 | | 3.39 | | |
| Pension assets/GDP | Overall | N=416 | 31.99 | 41.87 | 0.00 | 177.83 |
| | Between | n=54 | | 38.36 | | |
| | Within | T=3-10 | | 7.38 | | |
| (Pension assets/GDP) growth | Overall | N=354 | 12.87 | 32.76 | -42.75 | 410.54 |
| | Between | n=54 | | 29.81 | | |
| | Within | T=2-9 | | 23.94 | | |
| Rate of return pension sector | Overall | N=540 | 5.99 | 8.66 | -26.87 | 28.20 |
| | Between | n=54 | | 0.73 | | |
| | Within | T=10 | | 8.63 | | |

Notes: *The mean, standard deviation, minimum, and maximum are in full percentage points. N is the total number of observations, n is the number of countries, and T is the number of years. The rate of return of the pension sector is calculated by using the MSCI World Gross Return Index, the Barclays Capital Global Aggregate Bond Index, and the 3-month T-bill rate plus data on the share of pension assets that is invested in stocks, bonds and cash.*

## 5.4 Empirical Results

In this section we present our empirical strategy and the regression results. We first examine possible short-run effects and then possible long-run effects.

### 5.4.1 Short-run effects

To examine whether changes in the degree of pension funding affect economic growth in the short-run we estimate the following regression model:

$$\log(y_{it}/y_{i,t-1}) = \mu_i + \delta_t + \gamma_1 \log(y_{i,t-1}/y_{i,t-2}) + \gamma_2 \log(PA_{i,t-1}/PA_{i,t-2}) + \gamma_3 \, \text{ror}_{it} + \epsilon_{it}, \quad (5.1)$$

where $y$ is real GDP per capita of country $i$ in year $t$, $PA$ is the ratio of pension assets over nominal GDP, $ror$ is the rate of return of the pension sector, $\mu_i$ is a country fixed effect, $\delta_t$ is a time fixed effect, and $\epsilon$ is the error term. With this approach we focus on a possible short-run effect of funding on growth during the transition from a

PAYG to a (partly) funded system.

The country fixed effect $\mu_i$ is included to allow different countries to have different steady-state growth rates. We also estimate equation (5.1) without country fixed effects, using a simple pooled OLS model. Whereas the fixed effects model can only identify the possible effect of changes in the degree of funding within countries, without the country fixed effects it is possible to identify the effect of changes within and between countries. The drawback is that we then assume that all countries grow at the same rate, ceteris paribus.

The amount of pension assets is measured on the last day of the year. Note that we take the first lag of the growth in pension assets to prevent possible reverse causality. Furthermore, it is very hard to think of a situation in which changes in pension funding would immediately influence economic growth. Therefore, changes in the amount of pension assets during period $t-1$ are assumed to influence economic growth in period $t$.

Widely used estimators for dynamic panel models include the Arellano-Bond and Blundell-Bond estimators (Arrelano and Bond, 1991, Blundell and Bond, 1998), both of which were developed for small $T$, large $n$ panels, where $T$ refers to the time dimension and $n$ to the cross-sectional dimension of the data. With 54 cross-sections our $n$ is too small relative to our $T$ (8), to employ these estimators.

As an alternative, we consider the within (or LSDV) estimator. Nickell (1981) shows that this estimator is not consistent for finite $T$ in dynamic panel data models, where the inconsistency for $n \to \infty$ is $O(T^{-1})$. In other words, the inconsistency is inversely proportional to $T$ and disappears when $T$ becomes very large. However, our $T$ is 8, and the bias in our estimates will be considerable when we use the within estimator for our dynamic panel model.

Accordingly, we use a bias-corrected LSDV estimator for equation (5.1). Bun and Kiviet (2003) provide LSDV bias approximations, extended to unbalanced panels by Bruno (2005a). The analytical approximation of the bias that we use has order $O(T^{-1})$, the simplest bias approximation that Bun and Kiviet (2003) consider. It still accounts for most of the bias in the LSDV estimator when $nT \geq 400$ and $n \geq 10$. We initialize this bias correction procedure with a standard Blundell-Bond estimator with no intercept (see Bruno (2005b) for details). In addition, we use a non-parametric bootstrap procedure to estimate the asymptotic variance-covariance matrix of the bias-corrected LSDV estimates. Kiviet and Bun (2001) show that this variance estimator is superior to the standard analytical variance estimator.

Table 5.2 presents the estimates of equation (5.1). We show results from four dif-

Table 5.2. *Short-Run Effect of Funding on Growth*

| *Dependent variable* | Real GDP per capita growth | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| lagged real GDP per capita growth | 0.488 | 0.458 | 0.638 | 0.637 |
| | (0.073)*** | (0.073)*** | (0.058)*** | (0.059)*** |
| (Pension assets/GDP) growth | 0.001 | 0.003 | -0.005 | -0.005 |
| | (0.005) | (0.005) | (0.010) | (0.010) |
| rate of return pension sector | | 0.056 | | 0.018 |
| | | (0.028)** | | (0.027) |
| Observations | 317 | 317 | 317 | 317 |
| $R^2$ | - | - | 0.72 | 0.72 |

Notes: *Columns 1 and 2 estimated by the bias-corrected LSDV estimator. Numbers in parentheses are bootstrap standard errors. Columns 3 and 4 estimated by OLS (without country fixed effects). Numbers in parentheses are clustered standard errors. *,**,*** denote significance at 10%, 5% and 1% respectively. Growth-variables and the rate of return are measured as fractions. The rate of return of the pension sector is calculated by using the MSCI World Gross Return Index, the Barclays Capital Global Aggregate Bond Index, and the 3-month T-bill rate plus data on the share of pension assets that is invested in stocks, bonds and cash.*

ferent specifications, with and without country fixed effects, and with and without the rate of return of the pension sector as control variable. All four specifications include a full set of time fixed effects. In columns 1 and 2 we show results with country fixed effects, estimated by the bias-corrected LSDV estimator. In columns 3 and 4 we show results without country fixed effects, estimated by pooled OLS. In order to account for possible serial correlation in the residuals, we cluster the standard errors across cross-sections (countries) in columns 3 and 4.

As discussed before, the relationship between pension assets and the rate of return might be two-sided. On the one hand, high rates of return increase the growth rate of pension assets beyond what is caused by changes in funding. On the other hand, if countries decide to increase the funding ratio of their pensions this might have a positive effect on the rate of return. Thus, if we include the rate of return as a control variable, we also correct for that part of the growth in pension assets that affects the rate of return[3]. However, if we do not include the rate of return we ignore the possible effect of the rate of return on pension assets. Therefore, the true effect of changes in funding on economic growth will be somewhere in between the estimates with and without the rate of return included.

In all specifications the coefficient estimate of the growth of pension assets is very close to zero and insignificant. The autoregressive parameter ($\gamma_1$) is between 0.4 and 0.7, while the rate of return has a positive effect, as expected, but is only

[3] We would like to thank an anonymous referee for pointing this out.

significant in the model with country fixed effects. Furthermore, the inclusion of the rate of return hardly affects the relationship between changes in funding and economic growth, in contrast with our expectations.

All in all, we are led to conclude that changes in the degree of pension funding do not influence economic growth in the short-run. At least, not in the period between 2001 and 2010 in a large sample of OECD and non-OECD countries.

### 5.4.2 Long-run effects

Although we are not able to find an effect of changes in the degree of funding on economic growth in the short-run, there are several channels through which funding might impact upon growth that need somewhat more time. For example, it will probably take a few years before a larger pool of savings will translate into a higher rate of capital formation and thus higher economic growth. Therefore, we examine how changes in the degree of funding affect average economic growth in the years after the change. We start with a simple visual inspection of the data.

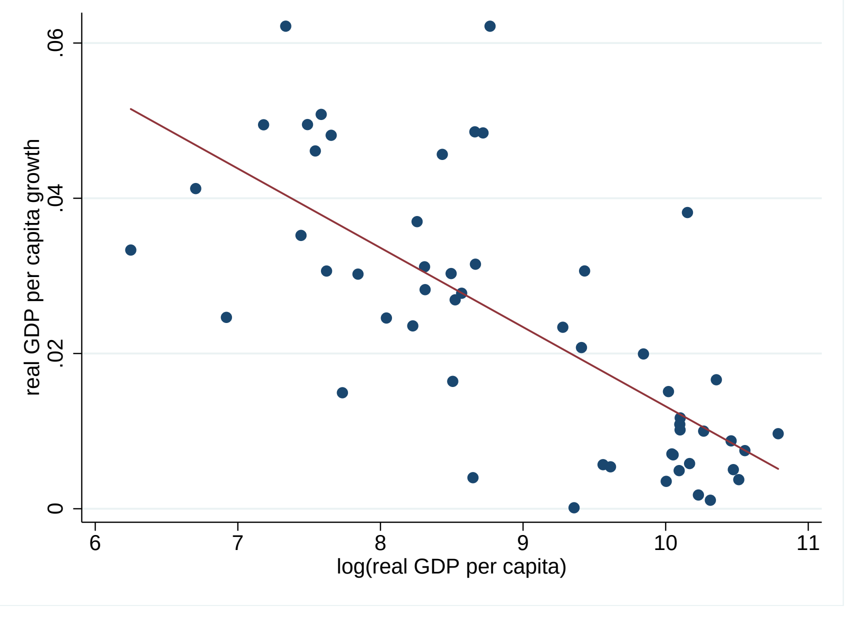


Figure 5.1. log(real GDP per capita) plotted against real GDP per capita growth (measured as a fraction)

Figure 5.1 plots log(real GDP per capita) against real GDP per capita growth. As expected, and predicted by the convergence literature (see Barro (1997)), the

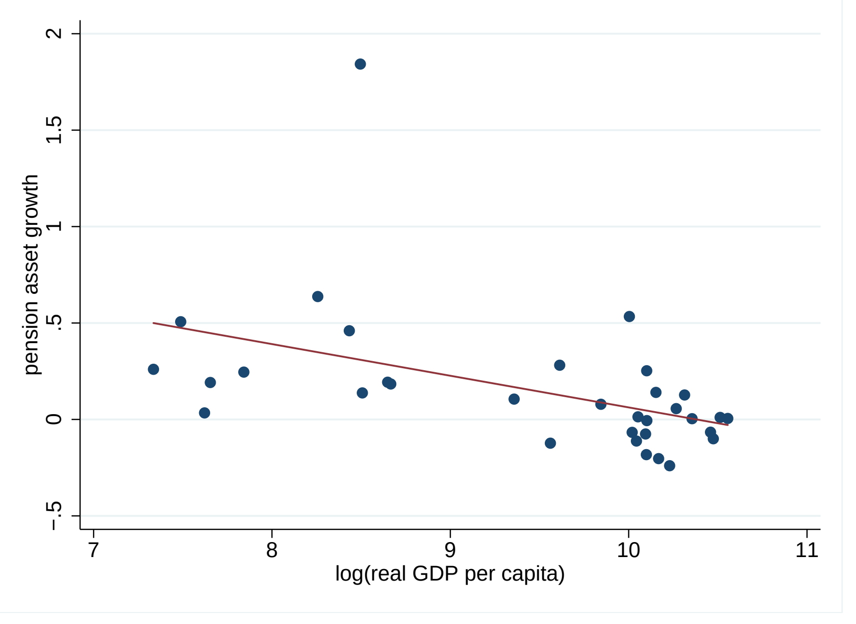


Figure 5.2. log(real GDP per capita) plotted against pension asset growth (measured as a fraction)

relationship is negative; poor countries grow faster than rich countries. However, from figure 5.2 the relationship between log(real GDP per capita) and pension asset growth seems to be negative as well. Thus, it are mainly poor countries that have high levels of pension asset growth. Then, simply looking at the bivariate relationship between pension asset growth and economic growth, as in figure 5.3, reveals a positive relationship between the two; countries with high levels of pension asset growth tend to grow faster than countries with low (or negative) pension asset growth. The positive relationship becomes even stronger if we drop the obvious outlier.

However, the question is whether this positive link between changes in funding and economic growth remains when we control for initial income. It might be that poorer countries do not grow faster because they reformed their pension system, but simply because they are catching-up with the developed world. In that case, it is a convergence effect that is at work and not an effect of pension funding on economic growth. Besides that, for countries with hardly any pension assets at all it is much easier to achieve enormous growth in pension assets as it is for countries with almost fully funded pension systems. This is simply due to the nature of the

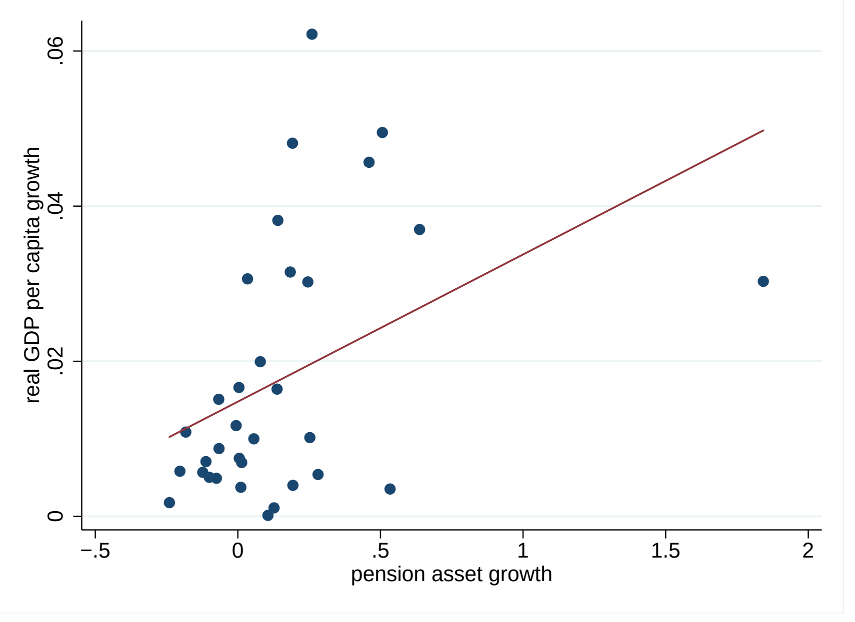


Figure 5.3. Pension asset growth plotted against real GDP per capita growth (both variables measured as a fraction)

growth rate as a measure of changes in funding. Therefore, we will estimate regression models with and without initial income included. Thus, to find out whether there are long-run effects of changes in the degree of funding of the pension system on economic growth we use a classical empirical growth model (see e.g. Barro (2001), Rodrik (2008)):

$$\frac{1}{T}\log(y_{i,t+T}/y_{it}) = \gamma_0 + \gamma_1 \log(y_{it}) + \gamma_2 \log(PA_{i,t}/PA_{i,t-1}) + \gamma_3 \,\mathrm{ror}_{it} + \epsilon_{i,t+T}, \tag{5.2}$$

where the year $t$ is 2002, $T$ equals 7, and all other variables are as defined before. We thus regress the average growth rate over the period 2002-2009 on the (log) level of income in 2002, the growth rate of pension assets from 2001 to 2002, and the rate of return of the pension sector in 2002. Because the amount of observations is very limited we use the period 2002-2009 instead of 2002-2010 as economic growth rates for 2010 are not (yet) available for all countries.

Table 5.3. *OLS Estimates of Long-Run Effect of Funding on Growth*

| *Dependent variable* | Average real GDP per capita growth 2002-2009 | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| log real GDP per capita | | -0.012 | | -0.013 |
| | | (0.002)*** | | (0.002)*** |
| (Pension assets/GDP) growth | 0.019 | 0.003 | 0.021 | 0.006 |
| | (0.009)** | (0.004) | (0.010)* | (0.004) |
| rate of return pension sector | | | -0.027 | -0.065 |
| | | | (0.032) | (0.029)** |
| Observations | 33 | 33 | 33 | 33 |
| $R^2$ | 0.18 | 0.62 | 0.19 | 0.71 |

Notes: *Numbers in parentheses are robust standard errors. *,**,*** denote significance at 10%, 5% and 1% respectively. Growth-variables and the rate of return are measured as fractions. The rate of return of the pension sector is calculated by using the MSCI World Gross Return Index, the Barclays Capital Global Aggregate Bond Index, and the 3-month T-bill rate plus data on the share of pension assets that is invested in stocks, bonds and cash.*

Table 5.3 presents the results of estimating equation (5.2). We show the results for several specifications; with and without the rate of return as control variable, and with and without initial income included.

Looking at the estimates for the growth rate of pension assets, it turns out to be significantly positive when we do not include initial income in the regression. But, when we do include initial income, which is significantly negative, the point estimate of the growth rate of pension assets decreases and becomes insignificant. Furthermore, the $R^2$ dramatically increases. This is exactly what we discussed above; apparently relatively poor countries, with high growth rates of pension assets, grow faster than rich countries because they are poor and not because their pensions are being funded. Finally, the rate of return of the pension sector has a negative effect on growth, which seems to contradict theory, but does not qualitatively alter the effect of changes in funding on growth.

One of the drawbacks of the simple cross-sectional model is that it leaves us with only 34 observations. It might be that we do no find significant effects because we simply do not have enough data. We therefore estimate a model with overlapping observations as well. Average economic growth between 2002 and 2006 is regressed on income in 2002, the growth of pension assets from 2001 to 2002 and the rate of return of the pension sector in 2002, average economic growth between 2003 and 2007 is regressed on income in 2003, the growth of pension assets from 2002 to 2003 and the rate of return of the pension sector in 2003, and so on. This yields 5 observations for countries with no missing data, and a total amount of 199 observations for all countries together.

We estimate this model with pooled OLS, as the number of observations for each cross-section is too limited to estimate a fixed effects model. In order to account for serial correlation within clusters (countries), serial correlation caused by the overlapping observations, and correlation between groups we should calculate Hodrick-standard errors (Hodrick, 1992). However, as these are not available for panel data, we calculate clustered bootstrap standard errors (see Cameron et al. (2008)) where we cluster by country. We thus assume correlation within countries over time. The results are in table 5.4.

Table 5.4. *OLS Estimates of Long-Run Effect of Funding on Growth (overlapping observations)*

| *Dependent variable* | Average real GDP per capita growth | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| log real GDP per capita | | -0.011 | | -0.011 |
| | | (0.002)*** | | (0.002)*** |
| (Pension assets/GDP) growth | 0.031 | 0.019 | 0.030 | 0.018 |
| | (0.009)*** | (0.007)** | (0.009)*** | (0.007)** |
| rate of return pension sector | | | 0.046 | 0.051 |
| | | | (0.019)** | (0.018)*** |
| Observations | 197 | 197 | 197 | 197 |
| $R^2$ | 0.12 | 0.33 | 0.14 | 0.35 |

Notes: *Numbers in parentheses are clustered bootstrap standard errors. *,**,*** denote significance at 10%, 5% and 1% respectively. Growth-variables and the rate of return are measured as fractions. The rate of return of the pension sector is calculated by using the MSCI World Gross Return Index, the Barclays Capital Global Aggregate Bond Index, and the 3-month T-bill rate plus data on the share of pension assets that is invested in stocks, bonds and cash.*

The growth rate of pension assets is significantly positive in all specifications although the point estimate becomes smaller when we include initial income, but it remains significant. The rate of return has a significantly positive effect on economic growth in all specifications. However, its inclusion seems to have hardly any effect on the estimate for the change in pension funding.

Finally, as figures 5.1-5.3 reveal, there are some obvious outliers present in the data. Therefore, we also estimated all models without these outliers. Most results are comparable to the results with the outliers included, with the exception of the model with overlapping observations. Leaving out 5 observations where the growth rate of pension assets exceeds 100% results in an insignificant estimate for the growth rate of pension assets when initial income is included (columns 2 and 4). We show these results in table 5.5. Furthermore, we also estimated the models with a few variables included that should proxy for steady-state growth (i.e., trade/GDP, investment/GDP). We do not show the results here, but they are also comparable to the results in tables 5.3 and 5.4.

Table 5.5. *OLS Estimates of Long-Run Effect of Funding on Growth (overlapping observations: without outliers)*

| *Dependent variable* | Average real GDP per capita growth | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| log real GDP per capita | | -0.011 | | -0.011 |
| | | (0.002)*** | | (0.002)*** |
| (Pension assets/GDP) growth | 0.039 | 0.014 | 0.038 | 0.014 |
| | (0.013)*** | (0.011) | (0.013)*** | (0.012) |
| rate of return pension sector | | | 0.042 | 0.047 |
| | | | (0.019)** | (0.016)*** |
| Observations | 192 | 192 | 192 | 192 |
| $R^2$ | 0.08 | 0.29 | 0.10 | 0.31 |

Notes: *Numbers in parentheses are clustered bootstrap standard errors. *,**,*** denote significance at 10%, 5% and 1% respectively. Growth-variables and the rate of return are measured as fractions. The rate of return of the pension sector is calculated by using the MSCI World Gross Return Index, the Barclays Capital Global Aggregate Bond Index, and the 3-month T-bill rate plus data on the share of pension assets that is invested in stocks, bonds and cash.*

The evidence for a long-run effect of changes in funding on economic growth seems to be mixed. We only find a positive effect when we use a model with overlapping observations, but this positive effect disappears when we exclude a few outliers. The point estimate in the model with the outliers included is 0.018, which means that a 10 percentage points increase in the funding ratio would increase the average economic growth rate in the four years after the change with 0.18 percentage points, which seems to be rather modest[4].

## 5.5 Conclusions

In the short-run there does not seem to be a link between funding of pensions and economic growth. In light of the fact that most theoretical explanations of an effect of funding on growth focus on long-term effects, this finding is not surprising.

[4] One might wonder whether a possible selection bias is present. If the sample would mainly consist of countries that reformed their pension sector, this might be the case as a trigger for reform could be low economic growth rates. However, our sample contains countries that did reform but just as well countries that did not. Therefore, we believe that selection bias is hardly a problem here.

However, especially for developing countries increases in funding ratios might immediately lead to better developed capital markets and higher economic growth in turn. Nonetheless, it does not show up in our data.

In the long-run there might be a positive effect of funding of pensions on economic growth, although the effect seems to be modest; at most, a 10 percentage points increase in the funding ratio would increase the average economic growth rate in the four years after the change with 0.18 percentage points. Furthermore, only when we use a model with overlapping observations is there a positive effect that does not disappear after the inclusion of initial income, but even this effect is sensitive to the treatment of outliers. Note that we corrected the standard errors for the overlapping nature of the data in this model.

However, the growth rate of pension assets as a measure of changes in the degree of funding merits some further discussion. Quite a few developing countries hardly have any pension assets at all. If their pension assets/GDP ratio would increase from, say 0.5% to 2%, which is still very low, the growth rate of pension assets is 300%. On the other hand, if a country with a pension assets/GDP ratio of 80% would increase funding towards a pension assets/GDP ratio of 100%, which is quite a remarkable increase, the growth rate would only be 25%. Of course, if there is any effect of funding on growth, it should be larger in the latter country. However, countries with low levels of pension assets seem to grow faster, simply because they are predominantly low-income countries which tend to grow faster than high-income countries according to the convergence literature. Then, this would show up as a positive effect of changes in the degree of funding on economic growth, while it is actually due to the nature of the measure that we use.

Finally, our findings might reflect a weaker link between funding and saving than is commonly found, perhaps because pension funds invest a significant amount of their assets abroad. It also could be that additional savings do not translate into greater economic growth, or capital market development and reduced labor market distortions are less important than we think. Another possible explanation is the presence of a long-horizon effect that our dataset, covering one decade, cannot pick up. Further research clearly should attempt to find satisfactory explanations for our results. In particular, data about the fraction of assets that pension funds invest abroad would be helpful in order to calculate more precisely country-specific rates of return of the pension sector when using pension assets as a measure of funding.

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# Samenvatting (Summary in Dutch)

De meeste westerse landen worden geconfronteerd met een vergrijzende bevolking. In Nederland zal de verhouding tussen werkenden en gepensioneerden dalen van vier in 2012 tot twee in 2040 [5]. In andere westerse landen zijn de cijfers vergelijkbaar. Dit wordt veroorzaakt door twee dingen: Ten eerste, de babyboom na de Tweede Wereldoorlog. Dit heeft een tijdelijk effect op de bevolkingspiramide van westerse landen. De tweede oorzaak, de stijgende levensverwachting, is permanent. Deze stijgende levensverwachting vormt een grote uitdaging voor de kosten van de gezondheidszorg en ons pensioenstelsel.

Er zijn verschillende maatregelen genomen om de gevolgen van de vergrijzing op te vangen. De wettelijke pensioenleeftijd is verhoogd, er zijn maatregelen genomen om het arbeidsaanbod onder oudere werknemers te verhogen, en een aantal landen is overgestapt van een omslagstelsel naar een kapitaaldekkingsstelsel. Hoewel deze maatregelen primair bedoeld zijn om de vergrijzing het hoofd te bieden, zouden er mogelijke neveneffecten kunnen optreden. Davis en Hu (2008) stellen bijvoorbeeld dat de overgang van een omslagstelsel naar een kapitaaldekkingsstelsel economische groei bevordert.

Een andere ontwikkeling is de verschuiving van DB-regelingen (eindloon of middelloon) naar beschikbare premieregelingen. Een belangrijk kenmerk van een beschikbare premieregeling is dat individuen (of huishoudens) de investerings-, rente- en inflatieschokken zelf op moeten vangen, terwijl in een DB-regeling intergenerationele risicodeling deze schokken uitsmeert over meerdere generaties. Daarom kan de verschuiving van DB-regelingen naar beschikbare premieregelingen worden gezien als onderdeel van de bredere verschuiving naar meer individu-

[5] Bron: CBS StatLine, http://statline.cbs.nl

ele verantwoordelijkheid. Sparen voor pensioen wordt meer en meer een individuele taak, ook in Nederland.

Dit proefschrift probeert een aantal belangrijke vragen op het gebied van vergrijzing en spaargedrag van huishoudens te beantwoorden: Hoe beïnvloeden vervangingsratios het spaargedrag van huishoudens? Wat zijn de macro-economische effecten wanneer overheden besluiten om het pensioenstelsel te hervormen? Dit zijn de vragen die centraal staan in dit proefschrift. In totaal bestaat dit proefschrift uit vier studies: De eerste drie studies (hoofdstukken 2, 3 en 4) onderzoeken levenscyclus besparingspatronen, terwijl de laatste studie (hoofdstuk 5) gaat over het veronderstelde verband tussen de financiering van pensioenen (omslagstelsel of kapitaaldekkingsstelsel) en economische groei.

Het effect van de vervangingsratio op spaargedrag is belangrijk, omdat vervangingsratios dalen in de meeste westerse landen. Dit wordt deels veroorzaakt door de verschuiving van DB-regelingen naar beschikbare premieregelingen. Maar ook DB-regelingen zijn de laatste jaren minder genereus geworden. Om een scherpe daling van de levensstandaard na pensionering te voorkomen is het dus noodzakelijk dat huishoudens sparen voor hun pensioen.

Het onderzoeken van levenscyclus besparingspatronen (hoofdstukken 2, 3, en 4) is ook interessant vanwege de observatie dat out-of-pocket medische kosten nauwelijks bestaan in het Nederlandse zorgstelsel, dat publieke pensioenen (AOW) zeer gul zijn en dat het pensioenstelsel tot de beste stelsels ter wereld behoort. Dus waarom sparen Nederlandse huishoudens zo veel? Gezien vanuit een levenscyclusperspectief suggereert het feit dat ouderen nauwelijks ontsparen al dat er geen behoefte aan is.

Zoals eerder al beschreven, is één van de maatregelen die is genomen om de vergrijzing het hoofd te bieden het kapitaaldekkend maken van pensioenen. Het onderwerp van hoofdstuk 5 is geïnspireerd door één van de belangrijkste argumenten voor het kapitaaldekkend maken van pensioenen, namelijk dat een kapitaaldekkingsstelsel beter bestand zou zijn tegen grote schokken in de leeftijdsopbouw van de bevolking dan een omslagstelsel. Echter, ook een kapitaaldekkingsstelsel is kwetsbaar voor demografische schokken. Volgens Barr (2000) is het idee dat het kapitaaldekkend maken van pensioenen de effecten van een ongunstige leeftijdsopbouw van de bevolking tenietdoet één van de tien mythes over het hervormen van pensioenstelsels. Er zijn echter heel wat landen die hun pensioenstelsel hervormen tegen hoge kosten. Daarom willen we onderzoeken wat de macro-economische effecten van deze hervormingen zijn en of ze positief of negatief zijn.

## Hoofdstuk 2-4: Sparen over de levenscyclus

Sinds het levenscyclusmodel en de permanente inkomenshypothese 60 jaar geleden werden geformuleerd hebben vele studies de implicaties hiervan getest. Eén daarvan is dat huishoudens, geconfronteerd met een bultvormig inkomensprofiel over hun levenscyclus, sparen als ze jong zijn en ontsparen na pensionering zodat consumptie min of meer constant is over de levenscyclus.

Aanvankelijk werden vermogensprofielen onderzocht met behulp van discretionair vermogen. De resultaten van dit soort analyses zijn wisselend (zie Browning en Lusardi (1996)). De meeste studies vinden echter niet dat huishoudens interen op hun vermogen na pensionering en als ze het wel doen, slechts zeer beperkt. Er zijn verschillende verklaringen bedacht voor het ontbreken van ontsparing na pensionering. De belangrijkste hiervan zijn het zekerheidsmotief, onzekerheid over het moment van overlijden en een mogelijk erfenismotief.

Een alternatieve verklaring wordt gegeven door Jappelli en Modigliani (2006). Zij stellen dat verplichte pensioenpremies deel uit maken van besparingen en dat daarnaast pensioenuitkeringen moeten worden gezien als ontsparing. Volgens hen zorgt het negeren van pensioenvermogen ervoor dat de resultaten vertekenen en het levenscyclusmodel ten onrechte wordt verworpen. Ze tonen aan dat het toevoegen van pensioenvermogen aan discretionair vermogen een perfect bultvormig leeftijd-vermogensprofiel oplevert voor Italiaanse huishoudens.

Dit gaat echter voorbij aan het feit dat het ontwerp van een verplicht pensioenstelsel per definitie tot een bultvormig leeftijd-vermogensprofiel leidt. De beslissing om vermogen op te bouwen via het pensioenstelsel en dit vermogen weer af te bouwen na pensionering wordt niet bewust door huishoudens genomen. Daarom is het maar de vraag of door gebruik te maken van pensioenvermogen een geldige test van het levenscyclus model tot stand komt.

We stellen een test van het levenscyclusmodel voor die alleen discretionair vermogen gebruikt, maar daarnaast rekening houdt met de effecten van het pensioenstelsel op vermogensopbouw (en afbouw). In hoofdstuk 2 doen we dat op een indirecte manier met behulp van Nederlandse gegevens. We testen of opleidingsniveau is gerelateerd aan de hoeveelheid vermogen die huishoudens opbouwen voor pensionering, en de hoeveelheid vermogensdecumulatie na pensionering. Deze benadering maakt gebruik van de verschillen in de vervangingsratio tussen groepen Nederlandse huishoudens met verschillende opleidingsniveaus. In hoofdstukken 3 en 4 gebruiken we Amerikaanse data. Hoofdstuk 3 is vooral beschrijvend, we bespreken hoe we de vervangingsratio berekenen vanuit de Health and Retirement

Study (HRS) data, en we onderzoeken welke factoren samenhangen met de vervangingsratio. Tenslotte wordt in hoofdstuk 4 het directe verband tussen vervangingsratios en spaargedrag onderzocht met behulp van de vervangingsratios die we berekend hebben in hoofdstuk 3.

**Hoofdstuk 2: Het vermogensprofiel over de levenscyclus in relatie tot opleidingsniveau**

In hoofdstuk 2 wordt de volgende onderzoeksvraag behandeld:

***Hebben hoog opgeleiden een steiler vermogensprofiel over hun levenscyclus dan laag opgeleiden?***

Onze bijdrage aan de literatuur is tweeledig: Ten eerste nemen we de vervangingsratio als basis voor onze analyse van de verschillen in leeftijd-vermogensprofielen tussen groepen huishoudens. Ten tweede maken we gebruik van een lang panel (1995-2011) met Nederlandse data (DNB Household Survey (DHS)), wat ons in staat stelt om veranderingen in huishoudvermogen over de tijd te observeren. De combinatie van de hoge kwaliteit van de gegevens en een lang panel maakt de DHS zeer geschikt voor ons doel. Andere datasets zijn het IPO (Inkomens Panel Onderzoek), en het Socio-Economic Panel (SEP), die uit administratieve gegevens bestaat. Zoals Alessie et al. (1997) en Kapteyn et al. (2005) opmerken zijn aandelen, obligaties en spaarrekeningen zwaar ondergerapporteerd in het SEP en zijn meetfouten niet constant over de tijd.

Om enkele implicaties van het levenscyclusmodel en de permanente inkomenshypothese te testen onderzoeken we onderwijsspecifieke leeftijd-vermogensprofielen op huishoudniveau. Onze steekproef is een ongebalanceerd panel van 17 jaar (1994-2010) en circa 2.500 Nederlandse huishoudens. We vinden dat, zelfs na correctie voor permanent inkomen, hoogopgeleide huishoudens meer vermogen opbouwen voor pensionering dan laag opgeleide huishoudens. Bovendien, alleen hoogopgeleide huishoudens lijken te ontsparen na pensionering. Aan de andere kant eten huishoudens nauwelijks hun huis op na pensionering.

**Hoofdstuk 3: De vervangingsratio van Amerikaanse huishoudens**

In hoofdstuk 3 worden de volgende onderzoeksvragen behandeld:

***Hoe kan de vervangingsratio van huishoudens worden berekend op basis van de HRS data? Welke factoren correleren met de vervangingsratio?***

Het doel van dit hoofdstuk is vooral beschrijvend. We laten zien hoe vervangingsratios kunnen worden berekend op basis van de HRS data, we beschrijven de belangrijkste kenmerken van onze maatstaf, en we onderzoeken welke factoren zijn gecorreleerd met de vervangingsratio. Twee andere studies berekenen vervangingsratios vanuit andere gegevensbronnen: Bernheim et al. (2001) berekenen vervangingsratios op basis van de Panel Study on Income Dynamics voor 430 huishoudens en gebruiken deze om het effect van de vervangingsratios op vermogensopbouw te testen. Hurd et al. (2012) construeren vervangingsratios per opleidingsniveau en burgerlijke staat voor groepen huishoudens in een aantal OESO-landen om het effect van de generositeit van publieke pensioenen op levenscyclus besparingen te onderzoeken.

We vinden dat het geboortejaar van het hoofd van het huishouden een positief effect heeft op de vervangingsratio van de eerste pijler, en een negatief effect op de totale vervangingsratio. Met andere woorden, de generositeit van publieke pensioenen (Social Security) is verbeterd in de Verenigde Staten, maar de pensioenregelingen die door de werkgever worden aangeboden en 401(k) zijn minder genereus geworden. De geleidelijke stijging van de generositeit van de publieke pensioenen wordt waarschijnlijk veroorzaakt door het feit dat de hoogte van publieke pensioenen gekoppeld is aan de inflatie in plaats van algemene loonstijgingen. Andere bevindingen zijn een negatief verband tussen onderwijsniveau en gezinsinkomen enerzijds en de vervaningsratio anderzijds. Tot slot, het moment van pensioneren heeft alleen effect op de vervangingsratio van de eerste pijler. Hoe later het moment van pensionering, des te hoger de pensioenuitkering.

**Hoofdstuk 4: Spaargedrag van huishoudens in relatie tot de vervangingsratio**

In hoofdstuk 4 wordt de volgende onderzoeksvraag behandeld:

***Hebben huishoudens met een lage vervangingsratio een steiler vermogensprofiel over de levenscyclus dan huishoudens met een hoge vervangingsratio?***

Er bestaan veel studies over het verdringingseffect van pensioenvermogen op overig vermogen. Feldstein (1974, 1996) en Gale (1998) zijn de belangrijkste studies. De belangrijkste vraag in deze literatuur is of pensioenvermogen overig vermogen verdringt. Schattingen van dit effect variëren van bijna nul (geen verdringing) naar dicht bij minus één (volledige verdringing). Gerelateerd hieraan bestuderen we of de vervangingsratio invloed heeft op het spaargedrag van huishoudens, en in het bijzonder of vermogensprofielen over de levenscyclus worden beïnvloed door de vervangingsratio van huishoudens. Dus, in tegenstelling tot de literatuur over mogelijke verdringingseffecten gebruiken we geen pensioenvermogen, maar vervangingsratios. Eén van de belangrijkste verschillen tussen de literatuur en onze benadering is dat we huishoudens volgen over tijd, terwijl de meeste studies die verdringingseffecten schatten afhankelijk zijn van cross-sectie data.

Hoewel sommige recente papers (zie bijvoorbeeld Engelhardt en Kumar (2011)) administratieve gegevens voor pensioenvermogen gebruiken, wordt in de meeste studies gebruik gemaakt van enquêtegegevens. Het vereist nogal wat aannames om pensioenvermogen te berekenen op basis van enquêtegegevens. Om vervangingsratios te berekenen hoeven we alleen het inkomen voor en na pensionering te observeren. Het nadeel van onze aanpak is echter dat we niet in staat zijn om nauwkeurig het verdringingseffect als een waarde tussen 0 en 1 te berekenen. Toch zijn we in staat om de belangrijkste implicaties van het levenscyclus model te testen.

We bestuderen de impact van de vervangingsratio op het spaargedrag van huishoudens met behulp van de RAND HRS dataset. We schatten kwantielregressies met de verhouding tussen vermogen en permanent inkomen als afhankelijke variabele, en leeftijdsdummies en de vervangingsratio, geïnstrumenteerd door de mediane vervangingsratio per regio en sector, als de belangrijkste onafhankelijke variabelen. Onze studie is de eerste die expliciet vervangingsratios linkt aan vermogensprofielen. De drie belangrijkste bevindingen zijn als volgt: Ten eerste, op basis van IV regressies zijn we niet in staat om te concluderen dat de hoogte van het vermogen dat huishoudens hebben opgebouwd rond hun pensioenleeftijd, ten opzichte van permanent inkomen, stijgt naarmate de vervangingsratio daalt. Ten tweede, de vermogensprofielen van huishoudens in het hoogste kwartiel van de vervangingsratio-distributie zijn zeer vlak. Hun spaarquote is zeer laag en constant over de levenscyclus. Tot slot, huishoudens ontsparen nauwelijks na pensionering en sommige groepen blijven zelfs sparen na pensionering.

Deze resultaten betekenen dat we geen bewijs kunnen vinden voor de stelling dat Amerikaanse huishoudens meer vermogen opbouwen als reactie op het minder genereus worden van pensioenen. In het licht van de verschillende studies die beweren dat Amerikaanse huishoudens niet genoeg sparen voor hun pensioen (Mitchell en Moore (1998), Wolff (2002), Skinner (2007)), betekenen deze resultaten dat het minder genereus worden van pensioenen ervoor zorgt dat de financile situatie van gepensioneerde Amerikaanse huishoudens zal verslechteren.

## Hoofdstuk 5: Een kapitaaldekkingsstelsel en economische groei

In een omslagstelsel betalen werknemers pensioenpremies die worden gebruikt om de pensioenen te betalen aan gepensioneerden in dezelfde periode. In een kapitaaldekkingsstelsel betalen werknemers pensioenpremies aan een pensioenfonds en ontvangen ze een pensioenuitkering van dit pensioenfonds als ze met pensioen gaan. In een omslagstelsel zijn toezeggingen niet gedekt door onderliggend kapitaal omdat de premies onmiddellijk worden gebruikt om pensioenuitkeringen te betalen; bij een kapitaaldekkingsstelsel is er wel sprake van kapitaal. Tijdens de afgelopen decennia hebben een aantal landen hun pensioenstelsel hervormd van een omslagstelsel naar een kapitaaldekkingsstelsel. Een opmerkelijk voorbeeld is Chili, dat overstapte naar een kapitaaldekkingsstelsel in de jaren '80 van de vorige eeuw.

Echter, de overgang van een omslagstelsel naar een kapitaaldekkingsstelsel brengt transitiekosten met zich mee. Toen het omslagstelsel werd ingevoerd, ontving de eerste generatie gepensioneerden een pensioenuitkering zonder hier ooit pensioenpremies voor te hebben betaald. Deze meevaller moet impliciet worden terugbetaald bij de overgang naar een kapitaaldekkingsstelsel. Sommige studies (Holzmann (1997a,b), Davis en Hu (2008)) stellen dat tijdens de overgang van een omslagstelsel naar een kapitaaldekkingsstelsel economische groei zou kunnen toenemen, waarmee de transitiekosten deels worden gecompenseerd. De belangrijkste oorzaken van hogere economische groei zijn een hogere spaarquote, een efficiëntere arbeidsmarkt, en de ontwikkeling van kapitaalmarkten.
In hoofdstuk 5 wordt daarom de volgende onderzoeksvraag behandeld:

***Leidt de overgang van een omslagstelsel naar een kapitaaldekkingsstelsel tot hogere economische groei?***

Onze maatstaf voor de mate van kapitaaldekking is de verhouding tussen pensioenvermogen en het Bruto Binnenlands Product. Hoe hoger deze ratio, des te hoger de mate van kapitaaldekking. We dragen bij aan de bestaande literatuur door de mogelijke effecten van de hoogte van het nationaal inkomen aan het begin van de hervormingsperiode, en het rendement van de pensioensector mee te nemen in onze analyse. Bovendien, in tegenstelling tot andere studies, zoeken we naar een mogelijk effect van de mate van kapitaaldekking op economische groei op zowel de korte als lange termijn. Voor de korte termijn schatten we een dynamisch groeimodel met de groei van de verhouding tussen pensioenvermogen en het BBP als belangrijkste verklarende variabele. Onze steekproef is een ongebalanceerd panel van 54 landen over de periode 2001-2010. Om een mogelijk lange termijn effect te vinden gebruiken we een eenvoudig cross-sectie groeimodel dat we met OLS schatten.

Wat de korte termijn betreft zijn we niet in staat om enig effect van veranderingen in de mate van kapitaaldekking op economische groei te vinden. Het groeitempo van pensioenvermogen is in geen enkele specificatie statistisch significant, en de coëfficiënt schattingen liggen zeer dicht bij nul. Voor de lange termijn is het bewijs wisselend. Met een eenvoudig cross-sectie model vinden we geen effect als we corrigeren voor initieel nationaal inkomen in het regressiemodel; zonder initieel inkomen als controle variabele is het groeitempo van pensioenvermogen significant en positief. Het opnemen van initieel inkomen, dat negatief en significant is in alle specificaties, wordt gemotiveerd door de convergentie-hypothese: Arme landen groeien sneller dan rijke landen. Echter, als we een model met overlappende observaties schatten, vinden we een positief effect voor de mate van kapitaaldekking op economische groei, zelfs na correctie voor initieel inkomen. Het effect is echter gering. Hooguit zou een 10 procentpunt stijging van de mate van kapitaaldekking economische groei in de vier jaar daarna met 0,18 procentpunt verhogen.